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# METROPOLITAN WATER AND SEWERAGE BOARD

## NINTH ANNUAL REPORT

DECEMBER 31, 1909

JUN 22 [illegible]

COMPLIMENTS OF . . .

## METROPOLITAN WATER AND SEWERAGE BOARD.

HENRY H. SPRAGUE, CHAIRMAN.
HENRY P. WALCOTT.
JAMES A. BAILEY, JR.

1 ASHBURTON PLACE,
BOSTON.

WILLIAM N. DAVENPORT, Secretary.

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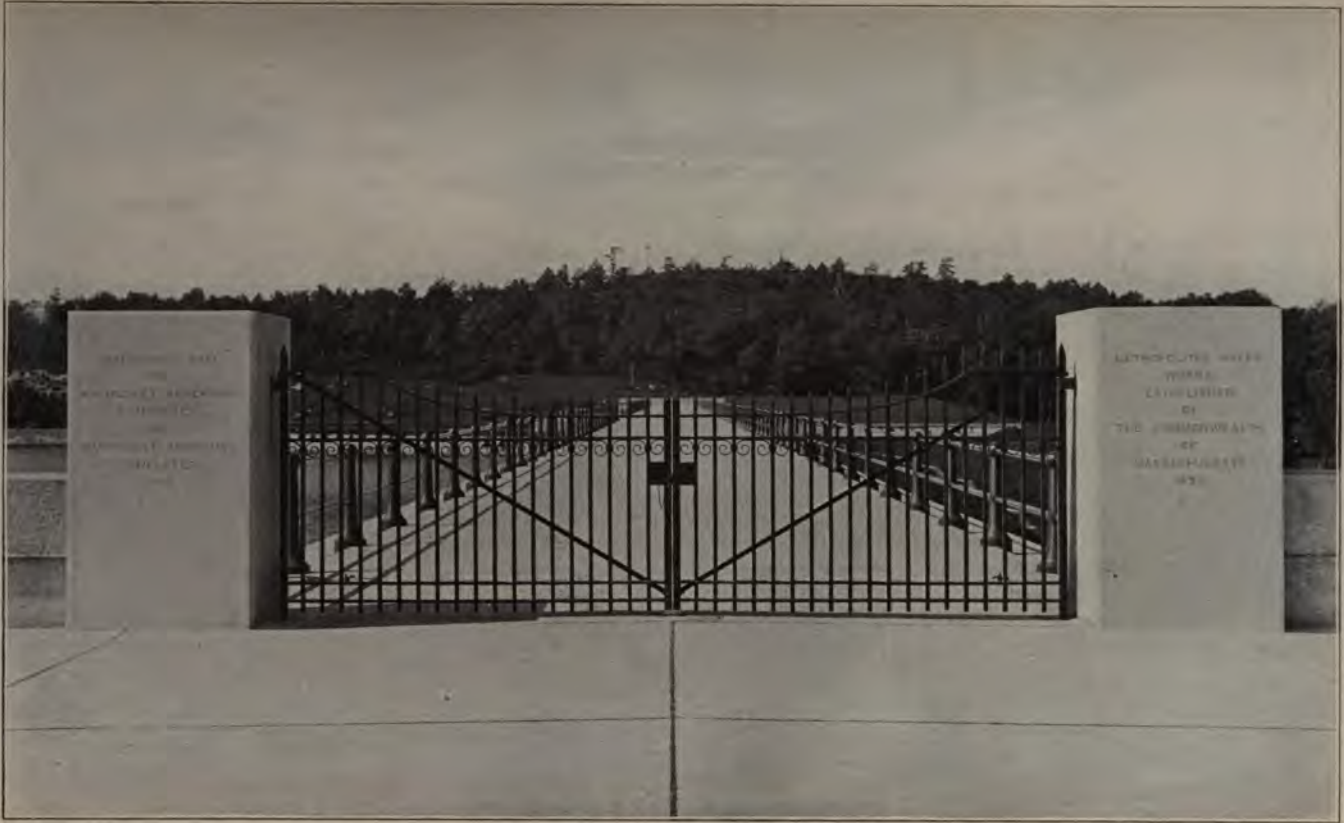

WACHUSETT DAM—INSCRIPTIONS UPON GRANITE POSTS ON GATEWAY AT TOP OF DAM.

Public Document No. 57

# NINTH ANNUAL REPORT

OF THE

# METROPOLITAN WATER AND SEWERAGE BOARD.

FOR THE YEAR 1909.

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# METROPOLITAN WATER AND SEWERAGE BOARD.

*To the Honorable the Senate and House of Representatives of the Commonwealth of Massachusetts in General Court assembled.*

The Metropolitan Water and Sewerage Board, established under the provisions of chapter 168 of the Acts of the year 1901, has already presented to your Honorable Body an abstract of the account of its doings, receipts, expenditures, disbursements, assets and liabilities for the fiscal year ending on November 30, 1909, and now, in accordance with the provisions of chapter 235 of the Acts of the year 1906, it presents a detailed statement of its doings for the calendar year ending on December 31, 1909, being its

## NINTH ANNUAL REPORT

made since the consolidation of the Metropolitan Water Board and the Board of Metropolitan Sewerage Commissioners on March 20, 1901.

## I. ORGANIZATION AND ADMINISTRATION.

### (1) Board, Officers and Employés.

The term of office of Henry H. Sprague expired on March 21, 1909, and he was reappointed for the three years next succeeding. The membership of the Board has consequently remained as in the preceding year: Henry H. Sprague, chairman, Henry P. Walcott, M.D., and James A. Bailey, Jr. William N. Davenport has continued as secretary and in charge of the auditing department. Alfred F. Bridgman has been the purchasing agent and Miss Alice G. Mason the bookkeeper.

There are also employed in the administrative office a paymaster, an assistant in auditing, two general clerks, three stenographers and clerks, a telephone operator, a messenger, and a janitor with two assistants, one of whom acts as watchman.

George D. Bigelow has been in charge of the conveyancing work, and he has been assisted by Miss Alline E. Marcy, title examiner. They have performed such general conveyancing work and made such further investigation of real estate titles in the different counties as has been called for during the year for the general purposes of the Board and for the assistance of the Attorney-General in pending suits.

The consulting engineers of the Board are Joseph P. Davis, Hiram F. Mills and Frederic P. Stearns, who are called upon for services when matters arise which require such consideration.

Dexter Brackett has been Chief Engineer of the Water Works, with supervision of the various departments of both construction and maintenance. William E. Foss, who until July 1 was, as Division Engineer, in special charge of construction work and of electrolytic investigations in the Metropolitan District, has since that date, as Assistant to the Chief Engineer, had a general charge of engineering work in all departments. Others acting under direction of the Chief Engineer have been: Elliot R. B. Allardice, Superintendent of the Wachusett Department; Charles E. Haberstroh, Superintendent of the Sudbury and Cochituate Works and of the portion of the Weston Aqueduct above the Weston Reservoir; Samuel E. Killam, Superintendent in charge of the Weston Reservoir and the remaining portion of the Weston Aqueduct and of all reservoirs and pipe lines within the Metropolitan District; Arthur E. O'Neil, Superintendent of the several pumping stations; Alfred O. Doane, Division Engineer in charge of engineering work at pumping stations; Benjamin F. Hancox, Assistant in charge of the Drafting Department; Arthur W. Walker, Biologist; William W. Locke, in charge of the sanitary inspection of the watersheds; and William E. Whittaker, Office Assistant.

On account of the increased amount of construction work in progress during the past year there has been an increase of about 20 per cent. in the engineering force employed. The average force in construction and maintenance during the year has included, in addition to the Chief Engineer, 4 department superintendents, 2 division engineers, 6 assistant engineers, and 35 others in various engineering capacities and as sanitary inspectors, clerks, stenographers and messengers, the total force numbering 47. The maximum engineering force employed at any one time during the year on both construction and maintenance was 54.

A maintenance force in addition to those engaged in engineering capacities as above mentioned, numbering upon the average during the year 249, has been required at the pumping stations, upon reservoirs, aqueducts, pipe lines, and upon minor construction work. At the end of the year this force numbered 216.

William M. Brown, as Chief Engineer of Sewerage Works, has continued in charge of both construction and maintenance. He has been assisted during the year by Frank I. Capen and Frederick D. Smith, Division Engineers, and Henry T. Stiff, Assistant Engineer, who have been in supervision of both construction and maintenance departments, by 1 assistant engineer all of the year and 3 assistant engineers during parts of the year, and by 22 others employed in various engineering capacities, and by 2 clerks and stenographers.

The maximum engineering force employed at any one time during the year on construction and maintenance of Sewerage Works was 28.

The regular maintenance force required in addition for the operation of the pumping stations, the care and inspection of the sewers and for other parts of the Sewerage Works, exclusive of the engineers and day-labor forces, has upon the average numbered 148.

The whole regular force of the Sewerage Department at the end of the year numbered 160, of whom the Chief Engineer and 17 assistants and draftsmen were engaged in general upon the works, and, of the remainder, 88 were employed upon the North System and 54 upon the South System.

Day-labor forces under the supervision of the engineers and the immediate direction of foremen have been employed in the construction of foundations, new channels and connecting chambers in preparation for the extension of the buildings and plant at the Deer Island pumping station, and in construction of a siphon under the new channel of Alewife Brook, on the Metropolitan branch sewer to Arlington.

The maximum number of men employed upon contracts and upon day-labor construction on the Sewerage Works during the year was for the week ending October 24, when the number amounted to 85.

### (2) Offices and Buildings.

The offices of the Board and of the secretary, the auditing and conveyancing departments, and the main engineering offices of both Water Works and Sewerage Works, are located in the buildings numbered 1 and 3 Ashburton Place, at the corner of Somerset Street, in Boston.

The office building belonging to the Board in Clinton and occupied as a branch office for the Wachusett Department of the Water Works has been given up, and the headquarters for this department have been removed to the gate-chamber and power-house at the Wachusett Dam. The branch office for the Sudbury Department is maintained at South Framingham. Headquarters of the maintenance force of the Water Works for the northern part of the Metropolitan District are maintained in the Glenwood pipe yard in Medford, where there are offices, shops, store-rooms and stables; and the maintenance force for the southern part of the District has headquarters in like buildings at the Chestnut Hill Reservoir.

Branch headquarters of the maintenance and repair forces of the Sewerage Works are maintained for the North Metropolitan System near the East Boston and Deer Island pumping stations, and for the South Metropolitan System at the Ward Street pumping station and at the storage yard at Hough's Neck.

## II. METROPOLITAN WATER DISTRICT.

Swampscott, although situated outside the 10-mile limit, was, under a special Act of the Legislature of the year 1908, admitted into the Metropolitan Water District on May 3, 1909. The sum of $90,000 was paid by the town on account of its admission. By an Act of the year 1909 it was provided that all sums which should be received from the town for admission to the District should be paid into the Metropolitan Water Loan Fund, and might be applied by the Board to the construction of works made necessary by the admission of the town into the District.

The District now comprises the cities of Boston, Chelsea, Everett, Malden, Medford, Melrose, Newton, Quincy and Somerville, and the towns of Arlington, Belmont, Hyde Park, Lexington, Milton, Nahant, Revere, Stoneham, Swampscott, Watertown and Winthrop, — in all, 9 cities and 11 towns. The District has an area of 174.8 square miles, and its population, as of the date of July 1, 1909, the date upon which calculations for the Water Works are based, is estimated at 1,022,260.

The city of Newton and the town of Hyde Park, however, though belonging to the District, do not take water from the Metropolitan sources, but still depend upon their own sources of supply.

## III. METROPOLITAN WATER WORKS — CONSTRUCTION.

The construction work upon the Metropolitan Water Works during the year 1909 has exceeded that of the previous year by more than 50 per cent. The principal work accomplished has been in the Distribution System, and has comprised the completion of the new main from the Chestnut Hill Reservoir to the Riverway in the city of Boston near the Longwood Avenue Bridge, the laying of mains for reinforcement of the water supply of Chelsea, Revere, Winthrop, Swampscott and Nahant, the laying of a main for the high service of the town of Belmont, and the provision for a new pumping engine for the southern high service. A beginning has also been made in the laying of a new main for bringing the supply from the Weston Aqueduct into the Metropolitan District. Some additions and improvements have been effected in connection with the Wachusett Reservoir and watershed and with Lake Cochituate, but these have been made upon the maintenance account.

The total amount expended for construction, including real estate and other property acquired, and payment of claims on account of the Water Works, during the calendar year 1909, was $359,667.13. Of this amount, $7,642.35 was expended on account of the Wachusett Dam and Reservoir; $4,135.50 for the improvement of the Wachusett watershed; $251 on account of the diversion of the waters of the South Branch of the Nashua River; $96,212.70 on account of the supply mains from the Weston Aqueduct; $242,304.50 for other construction in the Distribution Department; and the remainder, $9,121.08, for administration and other expenses. The total amount expended on account of construction since the beginning of the Water Works in the year 1895 has been $41,044,304.64.

## (1) WACHUSETT DAM AND RESERVOIR.

### (a) *Dam and Reservoir.*

The Wachusett Dam and Reservoir being regarded as completed works, some improvements and additions required have been made under the account of maintenance. The charges to construction have been mainly made in the settlement of old claims for depreciation of real estate and for injury to established business, and on account of the payment of a small amount of reserve held under former contracts.

### (b) *Clinton Catholic Cemetery.*

Efforts which it was hoped would prove successful have been made during the year to bring about a final settlement under the agreement which was made in the year 1898 with the Roman Catholic Bishop of the Diocese of Springfield and the St. John's Catholic Cemetery Association, by which the land acquired for the old cemetery in Clinton was taken and the bodies removed to the new site in Lancaster purchased by the Board for the purpose of the Association. Final papers were again prepared for execution by the Bishop and the Association, but, owing to controversies still existing among the parties, they have not been executed and returned. As repeatedly stated in previous reports, the Board, having long ago performed on its part all the stipulations of the agreement so far provided for, has been ready and desirous, in accordance with its terms, to pay over to the Association the balance of the money, amounting to $32,096.83, becoming due from the Commonwealth, and to convey to the Association the lands in Lancaster occupied for burial purposes, to which the Commonwealth holds the legal title, on receipt from the Bishop of a conveyance of the old cemetery lot, now submerged in the reservoir, and the release from the parties of all claims for damages.

## (2) IMPROVEMENT OF THE WATERSHEDS.

The appropriation available for the improvement of the Wachusett watershed was not sufficient to enter upon any large improvement on the construction account.

The Board has deemed it wise to purchase five small parcels of land situated on and near Lake Waushacum in the town of Sterling which became attainable for the better protection of the waters of the

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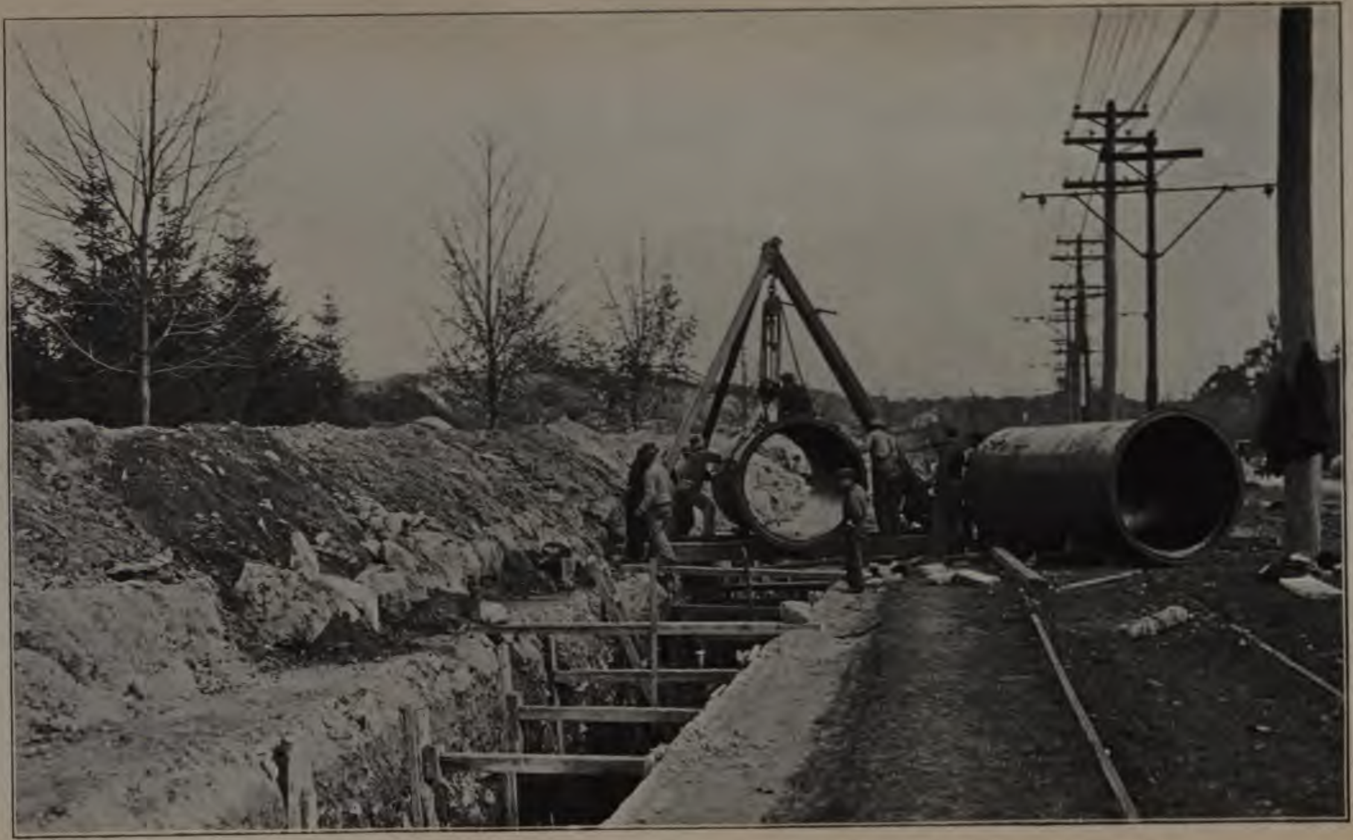


LAYING 60-INCH PIPE IN COMMONWEALTH AVENUE IN BRIGHTON.

lake, a feeder of the Wachusett Reservoir. The premises were such that they peculiarly threatened the purity of the water.

For like reasons it was deemed advisable to acquire a considerable tract of land in West Boylston through which a brook having a water privilege ran and emptied into the Wachusett Reservoir.

Other improvements have been effected not only in the Wachusett watershed but also in the Cochituate and Sudbury watersheds, but as these pertained more especially to maintenance the cost of these improvements has been defrayed from maintenance funds.

### (3) Weston Aqueduct.

Some claims under contracts arising on account of the construction of the Weston Aqueduct, the settlement of which has been long delayed by reason of pending suits, have been finally settled. The payments made under the settlements amounted to $1,627.35, making the total of expenditures for the construction of the Weston Aqueduct and Reservoir $2,849,490.11.

### (4) Distribution System.

#### (*a*) *New Supply Main for Boston Low-service District.*

The laying of a new 48-inch main from a point near the Chestnut Hill Reservoir through Beacon Street and Longwood Avenue to the Riverway near the Longwood Avenue Bridge in the city of Boston was completed and the line was put in service on September 14. This main was deemed especially necessary for the reinforcement of the low service in that city. The length of the main is 12,400 feet, and the cost of the work has amounted to $162,698.06. There are two small bills still to be paid. Inasmuch as the appropriation authorized for the purpose was $190,000, there will be left a balance amounting to more than $25,000.

#### (*b*) *New Weston Aqueduct Supply Main.*

Under the authority given by the Legislature of the year 1909 for the construction of a 60-inch main from the terminus of the Weston Aqueduct to the present mains near Chestnut Hill Reservoir, contracts have been made for the furnishing of about one-half of the iron pipes which will be required. A contract was also made in the latter part of the season for the laying of about 8,000 feet of pipe near the Chestnut Hill end of the line, principally through Chestnut Hill and Commonwealth avenues in Brighton. The estimate for the entire line was for an expenditure of $750,000. The value of the work done at the end of the year under the contract for laying the pipe was $25,902.53, and, in addition, pipes to the value of about $142,070 have been received.

The work of laying the pipe will be prosecuted during the coming year, and it is expected that about one-half of the entire length, being the part on the Chestnut Hill end, will be completed during the two coming seasons. By laying this portion of the pipe the more pressing necessities of the District will be relieved, and it is possible that the laying of the remainder of the line may be put off for a period of a year or two, but such possibility is dependent upon the continuance of a saving in the consumption of water such as has been effected during the past year. This main is supplied, in addition to the 48-inch pipe line which had previously been laid, for the purpose of bringing additional water from the Weston Aqueduct into the Metropolitan District, and is only one of several lines which will be required from time to time to supply the increasing necessities of the District.

(*c*) *Northern High-service Main in Everett, Chelsea and Revere.*

The laying of a new 24-inch main from the junction of Broadway and Hancock Street, in the city of Everett, through Chelsea to the junction of Fenno Street and Broadway in Revere, was begun and completed in the past year. This main has been laid to reinforce the present pipe line in order to give a sufficient pressure to the water supplied to Winthrop, Revere, Swampscott and Nahant. The laying of pipe was begun on July 20 and completed on December 17, and the whole line was put into service by the end of December. The estimated cost of the line was $68,000, for which, however, complete settlements have not yet been made.

As the laying of this main was made immediately necessary on account of the admission of the town of Swampscott into the Metropolitan Water District, the expense of construction is paid out of the sum received from the town on its admission into the District. This, however, is but a portion of the new work which will be required on account of the admission of the town into the Metropolitan Water District.

### (*d*) *New Main for the Supply of Winthrop.*

A new 16-inch main, 3,945 feet in length, has been laid during the past year from a point near the Beachmont railroad station in Revere to the Winthrop town line, to take the place of a main belonging to the town of Revere which had been used for the supply of Winthrop. The laying of pipe was begun on August 4 and the new main was completed and put into operation on October 23. The estimate made of its cost was $14,500, but the total expenditures have amounted to but about $12,500.

### (*e*) *Extra High-service Main to Belmont.*

A 12-inch pipe line from the standpipe on Arlington Heights to the Belmont town line has been required for the supply of buildings on the higher lands in Belmont. The pipe line laid has a length of 1,610 feet and was constructed in the latter part of the year and put into service on November 18. The cost of the line has been $4,604.43.

### (*f*) *New Pumping Engine at Chestnut Hill.*

The Board was authorized by the Legislature of last year to provide additional pumping machinery for the Southern High Service at Chestnut Hill. Competitive bids were called for, and as a result the contract for the pumping engine was awarded to the Holly Manufacturing Company of Buffalo, N. Y.

The new engine will have a daily capacity for pumping 40,000,000 gallons, and the contract price is $98,769. This pumping engine will be located in the low-service pumping station, and its completion is called for in the early part of the year 1911.

## (5) ACQUISITION OF LANDS AND SETTLEMENTS FOR DAMAGES.

### (*a*) *Acquisition of Lands.*

During the past year the Board has acquired in fee, by purchase or taking, 25.585 acres of land. Six small parcels in Sterling, aggregating 1.245 acres, were purchased, at a cost of $2,440, for the protection of the Wachusett watershed. A tract of 15.94 acres in West Boylston was also acquired for the same reason at a cost of $1,000. There were also acquired three parcels situated on the borders of Lake Cochituate in Natick, aggregating 2.86 acres, for the better protection of the waters of the lake. For these the sum of $813 was paid out of the maintenance appropriation. A tract of 3.99 acres in Framingham was also purchased out of the funds for maintenance, at an expense of $500, for the protection of Framingham Reservoir No. 3 in the Sudbury Department.

But a single taking was made, as follows: —

*Taking for Metropolitan Water Works for the Year 1909.*

| No. | Location and Description. | Former Owner. | Recorded. | Purpose of Taking. |
|---|---|---|---|---|
| 127 | Natick, — adjacent to lands of the Commonwealth on the margin of lake Cochituate, near West Central and Speene streets. Area, fee in 1.55 acres. | Devisees of Willard Morse. | 1909.<br>Nov. 24. | Improvement of Cochituate watershed. |

No settlements for lands acquired have been made aside from those effected upon the purchase of the lands above described.

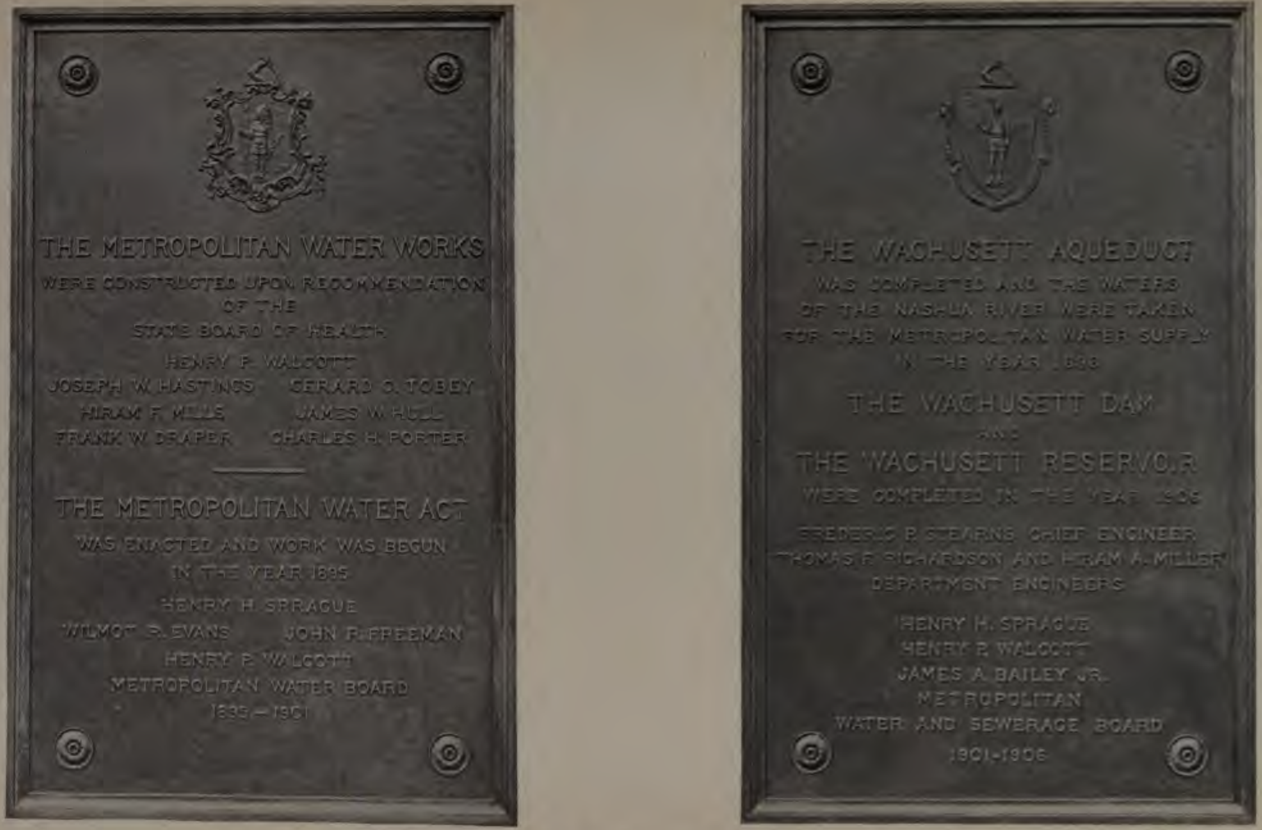
The settlements under purchases or takings of land for all purposes of the Water Works effected during the past year have been 11 in number, and for an aggregate of 24.035 acres. The sums paid in all these settlements have amounted to $4,753, and in all the cases the settlements have been effected by voluntary agreements.

### (*b*) *Depreciation of Real Estate.*

Settlements for depreciation in the value of real estate not taken by the Board were effected in 10 cases, 2 on account of lands situated in the town of West Boylston, amounting to $1,200, and 8 on account of lands situated in Boylston, amounting to $2,400, making a total for the year of $3,600. The 8 Boylston cases and 1 of the West Boylston cases were settled under awards made by commissioners appointed by the court. The other West Boylston case was settled by agreement out of court.

### (*c*) *Loss of Business.*

For injury to business caused by the carrying out of the Metropolitan Water Act in the towns of Boylston and West Boylston and in portions of the towns of Sterling and Clinton, settlements were made during the year in 3 cases, the amount paid being $650.



THE METROPOLITAN WATER WORKS
WERE CONSTRUCTED UPON RECOMMENDATION
OF THE
STATE BOARD OF HEALTH
HENRY P. WALCOTT
JOSEPH W. HASTINGS GERARD C. TOBEY
HIRAM F. MILLS JAMES W. HULL
FRANK W. DRAPER CHARLES H. PORTER

THE METROPOLITAN WATER ACT
WAS ENACTED AND WORK WAS BEGUN
IN THE YEAR 1895
HENRY H. SPRAGUE
WILMOT R. EVANS JOHN R. FREEMAN
HENRY P. WALCOTT
METROPOLITAN WATER BOARD
1895—1901

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THE WACHUSETT AQUEDUCT
WAS COMPLETED AND THE WATERS
OF THE NASHUA RIVER WERE TAKEN
FOR THE METROPOLITAN WATER SUPPLY
IN THE YEAR 1898
THE WACHUSETT DAM
AND
THE WACHUSETT RESERVOIR
WERE COMPLETED IN THE YEAR 1906
FREDERIC P. STEARNS CHIEF ENGINEER
THOMAS F. RICHARDSON AND HIRAM A. MILLER
DEPARTMENT ENGINEERS
HENRY H. SPRAGUE
HENRY P. WALCOTT
JAMES A. BAILEY JR.
METROPOLITAN
WATER AND SEWERAGE BOARD
1901-1906

WACHUSETT DAM—BRONZE TABLETS ON GATE AND POWER HOUSE.

### (*d*) *Diversion of Water.*

There has been paid during the year 1909, on account of a judgment obtained for the diversion of water, the sum of $250.

The sums enumerated as paid in the preceding cases do not include amounts paid for expert services and court expenses.

## IV. THE CONSTRUCTION OF THE METROPOLITAN WATER WORKS FROM 1895 TO 1910.

The Metropolitan Water Act, chapter 488 of the Acts of the year 1895, called for the construction of certain works within the first ten years following the passage of the Act, and certain other works within the succeeding ten years. The works contemplated for the first decade have been completed, as well as the larger part of those which were proposed for the second decade, which is now half completed.

The Act required the taking of the waters of the South Branch of the Nashua River; the building of the Wachusett Aqueduct; the building of the Wachusett Dam and Reservoir; the taking and completion of the Sudbury Dam and Reservoir; the taking of the other works of water supply of the city of Boston; the taking and utilization of Spot Pond; and the extension of the Distribution System, including the laying of water mains throughout the Metropolitan District, the making of distributing reservoirs and the enlargement and construction of pumping stations.

The Metropolitan Water Act of 1895 not only included many requirements additional to the original scheme recommended by the State Board of Health in its report to the Legislature, but subsequent acts of the Legislature have extended the requirements to works and damages beyond the provisions of the original Act.

### (1) The Taking of the Waters of the South Branch of the Nashua River.

The waters of the South Branch of the Nashua River were formally taken on February 23, 1898, and were directly afterwards diverted and made available for the water supply of the Metropolitan Water District, the Wachusett Aqueduct and other works having then been sufficiently completed for that purpose. Settlement had previously been made with the larger part of the parties entitled to damages on account of the diversion of the waters. The sums paid on account of water diverted, in cases where the damages were disconnected with other property or rights acquired or affected, have amounted to $1,212,995.42. This amount was paid to the various owners of manufacturing properties and water privileges along the Nashua River from the town of Clinton to the city of Nashua, and included a sum paid to that city for the damages which it suffered.

### (2) WACHUSETT AQUEDUCT.

Preliminary work necessary for the building of the Wachusett Aqueduct was begun directly after the organization of the Metropolitan Water Board in the year 1895, so that the water of the river might at as early a date as possible be diverted at the point in the town of Clinton where the proposed dam was to be erected and be brought as a water supply to the Metropolitan District. The actual work of construction was begun early in the year 1896, and the aqueduct, having a length of 12 miles in tunnel, covered masonry and open channel, was completed and water was introduced on March 7, 1898. The total cost of the aqueduct was $1,797,948.85, of which the sum of $1,536,895.48 was expended in the work of construction, $94,473.17 on account of real estate damages and expenses, and $166,580.20 in preliminary and engineering charges and expenses.

### (3) WACHUSETT DAM AND RESERVOIR.

Borings, soundings and other investigations were begun for fixing the location of the dam to be built on the Nashua River at Clinton directly after the organization of the Board in the year 1895. This work was followed in the year 1897 by the building of the temporary or coffer-dam just above the site selected for the great dam, not only as a preliminary to the construction of the latter, but also to enable the diversion of the water of the river into the Wachusett Aqueduct. In the year 1899 excavations were made in the bed and at the sides of the river, but it was not until October 1, 1900, that the general contract for the building of the dam was made. Work under the contract was continued until the year 1906, at which time the dam was regarded as completed, although the storage of water was begun as early as the year 1903, and other work has, since the year 1906, been carried on chargeable to the account of construction. The sum of $266,008.20 was expended for preliminary work and engineering; $120,173.53 was expended in the construction of the coffer-dam and other temporary works; $1,918,787.94 was spent on account of the main contracts for the building of the dam and the additional work thereunder; and $72,937.34 has been expended in the construction of the gate-house at the foot of the dam. The sums paid for the construction of the Wachusett Dam have thus amounted to $2,377,907.01.

Surveys preliminary to the construction of the Wachusett Reservoir were begun in the latter part of the year 1895. In the following year a beginning was made in clearing the territory of wood and brush and in the building of roads to take the place of those running through the area to be submerged. It was on July 26, 1897, that the first taking of lands was made, but considerable purchases of land for the reservoir had been previously effected. The first contract for stripping the reservoir and the removal of material was made on July 14, 1897. The work of excavating and removal of the soil was substantially completed in the year 1905, and the reservoir was for the first time filled to high-water mark on May 10, 1907.

The work involved the stripping of the soil and other material from an area of 6.44 square miles and the removal of 6,926,000 cubic yards of material. The expenditures for this work amounted to $2,536,612.66, of which amount the sum of $2,134,093.87 was expended under the contracts, $103,747.53 for additional work, and $298,771.26 for preliminary and engineering surveys.

The surface of the territory flanking the masonry dam on each side was in places lower than the high-water level of the reservoir, and to retain the water, dikes or embankments of earth were built. The North Dike extends for a distance of about 2 miles northwesterly, and the South Dike extends about 2,925 feet southerly from the dam. The sums of $792,264.68 and $137,075.55 were respectively expended for their construction, in addition to the cost of the reservoir proper. These sums do not include the cost of excavating from the reservoir the material which was used in the construction of the dikes, but do include the cost of depositing the material at the dikes.

Old roads running through the area within the limits of the reservoir were discontinued to the extent of 19.25 miles, and new highways and necessary bridges were constructed to take their place, the main highways being built from Clinton to Boylston and West Boylston both on the north and on the south sides of the reservoir. The length of all the highways constructed is 11.8 miles. Engineering and preliminary expenses amounted to $110,594.96, and the total sum of $437,272.50 was expended under contracts and work additional thereto. The total sum for construction of roads and bridges amounted to $547,567.76.

The relocation of the Central Massachusetts Division of the Boston & Maine Railroad, which ran through the entire length of the bed of the reservoir, became necessary, and the railroad was diverted to the northerly side of the reservoir. For a portion of the distance a new roadbed was constructed by the Board, and for the remainder, under an arrangement made with the railroad company, the track of the Worcester, Nashua & Rochester Railroad was utilized. The railroad construction involved the building of a tunnel about 1,080 feet in length, a steel viaduct over the river 921 feet long at a height of 133 feet above the valley, and a deep rock cut. The length of the relocation is 8.87 miles, being about one-third of a mile longer than the old location, which was superseded. The engineering and preliminary expenses attending the works were $72,301.02. Contracts and additional work thereunder amounted to $631,974.04, and there was paid to the Boston & Maine Railroad for a release of all the land and structures taken and damages incurred, including the compensation for the use of its tracks, the sum of $177,597.39. The total amount paid on account of the relocation was $881,872.45.

The building of the reservoir involved the purchase and taking of 7,945.58 acres, or 12.41 square miles, of land. Connected with these lands were 6 mills with water privileges attached, 4 churches, 8 schoolhouses, 492 residences and other buildings, a large cemetery in which 3,902 bodies had been buried, and a small cemetery in which had been buried 65 bodies. Engineering, legal and expert expenses in connection with the acquisition of the real estate amounted to $216,386.64. The sum expended for mill property and water rights was $1,402,200; for other real estate, including property outside of the direct margins of the reservoir, acquired for reservoir purposes, $1,439,914.88; and for sundry expenses, $148,263.61. The total expenditures for the acquisition of the real estate for the reservoir were $3,206,765.13.

The Metropolitan Water Act provided for the payment of indirect damages on account of injuries sustained by reason of the building of the reservoir. For depreciation in the value of real estate in the towns of Clinton, Boylston, West Boylston and Sterling which was not acquired there has been paid in 297 cases $289,588.24. On account of claims for loss of business in the same towns, caused by the carrying out of the Water Act, in 333 cases the sum of $156,699.18 was paid. There was paid on account of loss of employment to residents of West Boylston, to the number of 477, the sum of $85,959.65.

Legal and expert expenses incurred independently of the acquisition of real estate have amounted to $8,547.92. The total expenditure on account of indirect damages was $540,794.99.

### (4) The Clinton Sewerage System.

In the year 1898 the Metropolitan Water Board was required by the Legislature to intercept and to purify the sewage of the town of Clinton. For the purpose it was necessary to build a sewerage pumping station and to construct filter-beds. These works were begun at once upon the passage of the Act, and were completed and put into use in the year 1899. There was expended on account of engineering and preliminary work the sum of $22,860.82, for acquisition of real estate there was spent $37,794.40, for construction the sum of $88,908.19, and for sundry expenses $1,376.48, making a total expenditure of $150,939.89.

### (5) Taking and Completion of the Sudbury Dam and Reservoir.

The Board was required by the Metropolitan Water Act forthwith to take and complete the Sudbury Dam and Reservoir, the construction of which had been begun by the city of Boston, and to reimburse the city for the amount already spent for that purpose. The Board accordingly assumed the existing contracts for construction and proceeded to the completion of the dam and reservoir. The dam was completed so that water could be stored in the reservoir in the month of March, 1898, and the whole work was brought to entire completion in December of the same year.

For the construction of the Sudbury Dam, including preliminary work and engineering, there has been expended $648,792.45; and in like manner, for the construction of the reservoir, $1,623,673.91; for the purchase of land and margins, $621,367.43; and for legal, expert and general expenses, $29,299.92, making a total expenditure of $2,923,133.71. This amount includes the sum of $1,157,921.59 paid to the city of Boston in reimbursement for the expenditures previously made in the construction of the dam and reservoir. There were, besides, necessary additions to the pipe lines and siphon below the dam in connection with the Sudbury Aqueduct, amounting to $71,614.46.

### (6) TAKING OF OTHER BOSTON WORKS OF WATER SUPPLY.

On or before January 1, 1898, the Board was required to take, in addition to the uncompleted Sudbury Dam and Reservoir, all the other lands and works held by the city of Boston, for the purpose of supplying water and for storing and protecting the purity of the water, situated westerly of the Chestnut Hill Reservoir, together with the Chestnut Hill Reservoir and pumping station and other portions of the distributing system. The works taken included the small reservoirs in the Sudbury System, Lake Cochituate, the Mystic Water Works and also the Sudbury and Cochituate aqueducts. All this property was, therefore, taken at that date, and afterwards operated by the Board for the water supply of the Metropolitan Water District.

Settlement for the taking was effected with the city of Boston in the year 1900, and final payment on account of the amount due was made on October 29, 1901. The total amount paid to the city of Boston in addition to the sum paid on account of the Sudbury Reservoir was $12,768,948.80.

### (7) TAKING AND IMPROVEMENT OF SPOT POND.

The Board was also required to take, for the purposes of the water supply of the District, Spot Pond, situated principally in the town of Stoneham, and which was owned by the cities of Malden, Medford and Melrose, together with the lands and other property held by the said cities, for the purposes of water supply or protecting and preserving the purity of the water. The taking was accordingly made on January 1, 1898. After considerable controversy settlements were effected with the cities of Malden, Medford and Melrose by which they were paid, on account of the taking of the pond and property connected therewith, the sum of $1,240,229.62.

In order properly to purify the water for the purposes of the District it was deemed necessary to remove the mud and other organic material from the bottom of the pond and to enlarge its storage capacity, by which an increase in its capacity from 750,000,000 gallons to about 1,800,000,000 gallons was made. This improvement was effected at a cost of $582,188.73, but this cost is included under the expenditures for the Distribution System.

### (8) Distribution System.

The distribution of water to the various cities and towns of the Metropolitan District has necessitated the laying not only of large mains from the Chestnut Hill pumping station and from the terminus of the Weston Aqueduct, but various smaller mains in order to comply with the requirements of the Metropolitan Water Act that the Board should furnish water to each city and town by delivering the same into a main water pipe, reservoir or tank at sufficient pressure for use without pumping. The pipes laid vary in size from 60 inches to 6 inches, and in length amount to 92.53 miles, those of 36 inches and over measuring 48.09 miles in length.

The distribution of water has required in addition the erection of a new low-service pumping station and the enlargement of the old high-service station at Chestnut Hill, the erection of the Spot Pond pumping station, the building of a new pumping station at Arlington, the improvement of Spot Pond, the construction of the Fells Reservoir and Bear Hill Reservoir in connection with the improvement of Spot Pond, the construction of a distributing reservoir and standpipe at Forbes Hill in Quincy, and the acquisition of the Waban Hill Reservoir in Newton and Arlington standpipe on Arlington Heights.

The expenditures for the various purposes have amounted to $6,100,012.96.

### (9) Weston Aqueduct.

In the year 1900 the consumption of water in the Metropolitan District had so increased as to test the capacity of the Sudbury and Cochituate aqueducts for supplying the necessities of the District, and consequently the authority of the Legislature was obtained for the construction of an additional aqueduct from the Sudbury Reservoir to a point in Weston overlooking the Charles River. The construction of the aqueduct, with a capacity of carrying 300,000,000 gallons per day, including an equalizing reservoir in Weston, was begun in the same year, and the aqueduct was completed and put into operation in the year 1903.

The engineering and preliminary expenses attending the construction of the aqueduct amounted to $243,011.67. Contract and additional work amounted to $2,110,808.44. For the reservoir the engineering and preliminary expenses were $34,697.54 and the contract and additional work of construction amounted to $254,304.28. There was paid on account of real estate acquired the sum of $186,400.55, and legal, expert and other expenses amounted to $20,267.63. The total cost, therefore, of the Weston Aqueduct and Reservoir was $2,849,490.11.

### (10) PROTECTION OF THE WATER SUPPLY.

Work has been carried on from time to time for the protection and improvement of the water supplies of the Sudbury and Cochituate systems and also for the improvement of the two watersheds. The larger sums were expended in the drainage of swamps and other improvements in the Wachusett and Sudbury watersheds, for the protection of the Sudbury Reservoir and Lake Cochituate, and for the improvement of Lake Cochituate under the requirements of a statute passed in the year 1901. The expenditures have amounted to $575,396.74.

## (11) COST OF VARIOUS WORKS.

The expenditures for construction during the period from 1895 to 1910, on account of the various works have been as follows: —

| | | |
|---|---|---|
| Taking of waters of Nashua River, | | $1,212,995 42 |
| Wachusett Aqueduct, | | 1,797,948 85 |
| Wachusett Dam and Reservoir: — | | |
| Dam (including $193 for Power Plant), | $2,378,100 01 | |
| Reservoir, | 2,536,612 66 | |
| North Dike, | 792,264 68 | |
| South Dike, | 137,075 55 | |
| Roads and bridges, | 547,867 76 | |
| Relocation of railroad, | 881,872 45 | |
| Real estate, | 3,206,765 13 | |
| Indirect damages, | 540,794 99 | |
| | | 11,021,353 23 |
| Clinton Sewerage System, | | 150,939 89 |
| Sudbury Dam and Reservoir: — | | |
| Dam and Reservoir, | $2,923,133 71 | |
| Pipe line and siphon, | 71,614 46 | |
| | | 2,994,748 17 |
| Taking of Boston works of water supply, | | 12,768,948 80 |
| Taking of Spot Pond, | | 1,240,229 62 |
| Distribution System, | | 6,100,012 96 |
| Weston Aqueduct, | | 2,849,490 11 |
| Protection of water supply, | | 575,396 74 |
| Total expenditures for the various works, | | $40,712,063 79 |
| General expenditures applicable to all the works, | $281,453 29 | |
| Expenditures for engineering, conveyancing and legal expenses in common for acquisition of works of Boston, Malden, Medford, Melrose and Newton, | 73,128 47 | |
| | $354,581 76 | |
| Less stock acquired with Boston Water Works and charged to and included in Distribution account, | 22,340 91 | |
| | | 332,240 85 |
| Total of all expenditures, 1895-1910, | | $41,044,304 64 |

### (12) SETTLEMENTS FOR REAL ESTATE AND OTHER DAMAGES.

The total area of the lands acquired for the purposes of the Water Works since the beginning of operations in the year 1895, including lands in which easements have been acquired, has amounted to 16,970.002 acres, or 26.515 square miles. For these the settlements effected have been 895 in number, of which 843, being more than 94 per cent. of the whole number, have been made by voluntary agreements; and only 52 cases, or less than 6 per cent. of the whole, were settled upon judgments obtained in court.

Settlements have been effected with all owners of lands acquired for the Metropolitan Water Works who have made claims for damages within the time allowed by the statute, except in 4 cases involving about 2¾ acres.

The total area of lands acquired, however, includes the lands taken from the city of Boston with its water works for which settlement was made by agreement out of court, the lands originally acquired by the city of Boston for the construction of the Sudbury Reservoir for which reimbursement was made by the Board, the lands taken from the cities of Malden, Medford and Melrose in connection with Spot Pond for which settlement was made on the basis of an award by commissioners appointed by the court, and the Waban Reservoir lands acquired from the city of Newton under a voluntary agreement.

For all the remaining lands acquired by the Board the sum of $3,561,758.47 has been paid. In the settlements effected, 840 in number, 95.2 per cent. of the whole amount was paid under voluntary agreements, and 4.8 per cent. under judgments of the court. The legal, expert, court and miscellaneous expenses have amounted to $60,449.47, being 1.7 per cent. of the total amount of damages paid.

In the settlement of the damages arising from the diversion of the waters of the Nashua River, the damages paid amounted to $1,138,319.67, and of these, 80.6 per cent. were paid under voluntary settlements and 19.4 per cent. upon judgments obtained in court. The legal, expert, court and miscellaneous expenses amounted to $45,179.74, being 4 per cent. of the total amount of damages paid.

In the payment of the indirect damages for depreciation of real estate, damages to established business and for loss of employment, there were 1,107 claims, on which the total paid was $532,247.07.

Of these, 92.5 per cent. in number and 78 per cent. in amount were settled by voluntary agreement. The legal, expert, court and miscellaneous expenses amounted to $19,507.63, being 3.6 per cent. of the total damages paid.

For the settlement of the damages for the taking of the existing water works and in reimbursement to the cities of Boston, Malden, Medford, Melrose and Newton there was paid the sum of $15,227,100.01. The legal, expert, court and miscellaneous expenses of the Board amounted to $46,648.03, or 3/10 of 1 per cent. of the total sum paid in damages.

At the earlier period of construction special attorneys were paid by the Board, but in the later years, beginning with November 1, 1896, suits in court have been conducted by the Attorney-General and his assistants.

## V. WATER WORKS — MAINTENANCE.

### (1) Operation of Works.

The maintenance and operation of the Metropolitan Water Works extend to three large water pumping stations, two at Chestnut Hill and one at Spot Pond, two smaller pumping stations at Arlington and West Roxbury, two sewerage pumping stations, one upon Pegan Brook at Natick and the other at Clinton, ten storage reservoirs in the Cochituate, Sudbury and Wachusett watersheds, ten distributing reservoirs and standpipes at different locations within the Metropolitan District, the Cochituate, Sudbury and Wachusett aqueducts, the Clinton, Marlborough and Sterling filter-beds, 92.53 miles of main pipes for the distribution of water to the various cities and towns in the Metropolitan Water District, and, in addition, the various pipe yards, gate-houses, siphon and terminal chambers and other structures, dwelling houses for attendants and various other buildings used or held for operating purposes. Though the Mystic Reservoir is kept in service the Mystic pumping station and Mystic Aqueduct have not for some years been put into active operation.

### (2) Storage Reservoirs.

The reservoirs maintained for the collection and storage of water in the various watersheds, with their holding capacities, are as follows: —

| | Capacity in gallons. |
|---|---|
| **Cochituate watershed: —** | |
| Lake Cochituate, including Dudley Pond, | 2,242,400,000 |
| **Sudbury watershed: —** | |
| Sudbury Reservoir, | 7,253,500,000 |
| Framingham Reservoir No. 1, | 287,500,000 |
| Framingham Reservoir No. 2, | 529,900,000 |
| Framingham Reservoir No 3, | 1,180,000,000 |
| Ashland Reservoir, | 1,416,400,000 |
| Hopkinton Reservoir, | 1,520,900,000 |
| Whitehall Reservoir, | 1,256,900,000 |
| Farm Pond, | 167,500,000 |
| **Wachusett watershed: —** | |
| Wachusett Reservoir, | 64,968,000,000 |
| Total, | 80,823,000,000 |

Although the normal capacity of these reservoirs is 80,823,000,000 gallons, this total is in some years actually exceeded. The year 1909 began with a storage of 58,890,300,000 gallons, and this amount was gradually reduced until February 9, when the quantity in storage was 57,300,000,000 gallons. For the succeeding three months the greater rainfall caused a gradual increase in the quantity in storage until the maximum of 79,112,800,000 gallons was reached on June 14. The small amount of rainfall during the latter part of the year caused a gradual loss of storage, and on December 31 the total amount was 62,101,500,000 gallons, this being, however, greater by 3,211,200,000 gallons than the quantity at the beginning of the year.

The water in the Wachusett Reservoir at the beginning of the year was 15.13 feet below high-water mark, and it continued to fall until February 6, when it was 17.08 feet below the high-water mark of the reservoir. From this time the water rose until June 14, when it reached a maximum elevation of 394.4 feet, or 0.6 of a foot below high water. At this time the reservoir held 64,161,000,000 gallons. From June 14 there was a constant drawing down of the water until the end of the year, when the quantity held in storage was 48,667,800,000 gallons, and the water stood at 12.83 feet below high-water mark. No water was, therefore, discharged over the waste-weir into the river below the dam, although in accordance with the requirements of the Water Act an average of 2,536,000 gallons per day was drawn by pipes from the reservoir into the river.

The action of the waves has again caused a considerable recession of the banks both upon the north and south sides of the reservoir, and consequently it has been necessary to strip the soil from additional areas of land along the shores. Considerable quantities of roots, stumps and other débris have been collected about the reservoir and burned. Brush and weeds have been mowed along the entire margin of the reservoir. The slopes of the North and South dikes have been fertilized with material collected from the Clinton filter-beds. Additional town and property monuments have been erected, and various other improvements have been effected. There are 14 houses belonging to the Water Works which are rented, largely to employés of the Board, and considerable repairs are necessary to keep the buildings and grounds in good condition.

Some receipts have been had from the pasturage on outlying lands in the vicinity of the reservoir and from sand and gravel which have been sold. The grass about the shores of the reservoir and on outlying lands has been sold for sums aggregating $2,347.50.

An act was passed by the Legislature of the year 1909 authorizing the Board to permit, by lease, license or other agreement, the construction and maintenance of lines for the purpose of transmitting electric power over lands and waters held by the Board for water-supply purposes, it being provided, however, that no such permission should be given for a period of more than fifteen years.

Accordingly the Board granted to the Connecticut River Transmission Company permission to extend a line from a point in the northerly portion of the reservoir lands, along the northeasterly side of the reservoir and crossing the North Dike, a distance of about 6,100 feet, for the transmission of electricity to the Lancaster Mills. The Company has also been granted the privilege of erecting and maintaining a power-transmission line along the northwesterly side of the reservoir and crossing the reservoir at a point easterly of the Worcester Street Bridge. For these privileges the Company is to pay the sum of $400 per year.

The Sudbury Reservoir, which receives not only the comparatively small amount of water supplied from the watershed but also all of the water which is brought from the Wachusett Reservoir, has been kept substantially full during the entire year, and for nearly six months the water has been allowed to flow over the crest of the dam and into Framingham Reservoir No. 3, from which the water is drawn directly for the supply of the District.

Considerable improvements have been made in the swimming pool, which had been provided in the previous year for the benefit of the town of Southborough, by lessening the grade of the slopes of the shores and decreasing its depth, in order to render the pool more convenient and safe for bathers. The expense has been shared with the town of Southborough, and there have been provided by the town and its citizens other improvements to make the bathing pool more available for its purposes.

The ledge rock at the foot of the overflow of the Sudbury Dam, which had somewhat disintegrated through the combined action of frost and water and had been gradually wearing away, has been treated with cement concrete, and the cavities and open joints and seams have been pointed.

The water in Framingham Reservoir No. 3, in which is received a portion of the supply furnished from the Sudbury Reservoir and from which it is discharged into the Sudbury Aqueduct, has been maintained but little below the crest of the dam during the year. No water has been allowed to waste. A considerable amount of fencing has been done on the marginal lands of the reservoir in order to prevent the cattle from gaining access to the water from the adjacent pastures. Fences have also been to a considerable extent built about the Hopkinton Reservoir, to protect the lands of the Commonwealth.

In Lake Cochituate the water was maintained during the first half of the year at a little below high-water mark. Later the lake was drawn down to a depth of about 8 feet, but subsequently the water was allowed to rise, until at the end of the year it was 5½ feet below high-water mark.

Considerable work has been done during the year for the purpose of protecting the purity of the water and improving the conditions around the lake. Several strips of land have been acquired in order to increase the margins controlled by the Board, and several coves about the lake where the water was shallow have been filled with material excavated from the bed of the lake.

Surveys have been made and plans completed for the construction of works for the diversion of the surface drainage from Cochituate

Village and to carry this drainage outside the watershed. Proposals for the construction of the work under the specifications prepared were offered, but the lowest bid which was received was so great that it was evident that the entire work could not be finished within the appropriation of $30,000, which had been made by the Legislature for that purpose. This was largely for the reason that it seemed necessary in making definite specifications to include some additional work beyond that which had been made the subject of the estimates, and labor and materials had also seemed to advance since the original estimates were made. It was, therefore, deemed wiser to reject all of the bids and to postpone the work until another season, in the meantime recommending to the Legislature an additional appropriation of $6,000. Advantage, however, was taken of the low state of the water to extend a pipe across the culvert between the north and middle divisions of the lake, which could not ordinarily be done early in the season. It is expected that if the increased expenditure is authorized the work will be begun at an early period of the season and completed during the year.

The smaller reservoirs were generally kept about full during the year and there were no extra repairs required upon them.

From the Wachusett Reservoir an average of 99,312,000 gallons per day was drawn through the Wachusett Aqueduct into the Sudbury Reservoir. From the Sudbury Reservoir an average of 29,440,000 gallons per day was drawn through the Weston Aqueduct for distribution into the Metropolitan District, and directly from the Sudbury Reservoir, through Framingham Reservoir No. 3, 81,046,000 gallons per day were conveyed to Chestnut Hill through the Sudbury Aqueduct. There was also drawn from Framingham Reservoir No. 2 and conveyed through the Sudbury Aqueduct an average of 2,467,000 gallons per day, and from Lake Cochituate an average of 6,774,000 gallons per day was drawn and conveyed through the Cochituate Aqueduct to the Chestnut Hill Reservoir. The Spot Pond watershed furnished 289,890 gallons per day. Over 40 per cent. more water was drawn from Lake Cochituate during the year than in the preceding year. On the other hand, about 8,000,000 gallons per day less were drawn from the Wachusett Reservoir, being a decrease of a little more than 13 per cent.

A small quantity of water was drawn from the Hopkinton Reservoir which was supplied to the District through Framingham Reservoir No. 2, but no water was furnished to the District from Framingham Reservoir No. 1, Ashland Reservoir, Whitehall Reservoir or Farm Pond. The town of Framingham, however, obtained the larger portion of its water supply through the filter gallery from Farm Pond, though a small portion was also directly taken from the Sudbury Aqueduct.

### (3) DISTRIBUTING RESERVOIRS.

The following are the distributing reservoirs and standpipes maintained by the Board within the Metropolitan District: —

| | Capacity in Gallons. |
|---|---|
| Spot Pond, | 1,791,700,000 |
| Chestnut Hill Reservoir, | 300,000,000 |
| Weston Reservoir, | 200,000,000 |
| Fells Reservoir, | 41,400,000 |
| Mystic Reservoir, | 26,200,000 |
| Waban Hill Reservoir, | 13,500,000 |
| Forbes Hill Reservoir, | 5,100,000 |
| Bear Hill Reservoir, | 2,450,000 |
| Arlington Standpipe, | 550,000 |
| Forbes Hill Standpipe, | 330,000 |
| Total, | 2,381,230,000 |

These reservoirs, having a total capacity of 2,381,230,000 gallons, are kept full during the year, not only for the purpose of providing for a proper distribution of water throughout the District, but also in order to afford protection and relief in cases of accident and emergencies. The distributing reservoirs would, even if the outside sources of supply were all cut off, furnish the regular supply of the District for a period of nearly 20 days.

### (4) AQUEDUCTS.

The Wachusett Aqueduct was in operation for periods amounting to nearly 306 days during the year. The masonry interior of the aqueduct was not cleaned during the year, but it was necessary to remove the weeds and grasses from the open channel, which was accomplished while the channel was emptied in order to introduce the pipe for the Westborough Insane Hospital. The water was, however, cut off for the purpose of increasing the storage in the reservoir at times when there was a sufficient supply for the District from the smaller reservoirs which otherwise would have been overflowing. The Sudbury Aqueduct was in continuous use during the year and the Cochituate Aqueduct was in operation for periods amounting to more than 125 days. The Weston Aqueduct was in service for about 359 days, its operation being suspended at intervals amounting to about 7 days.

Some renovation and repairs were required upon the Wachusett Aqueduct, and it was also deemed advisable to construct fences along considerable portions of the open channel and aqueduct, in order to prevent cattle from entering upon the aqueduct lands. It was necessary thoroughly to repoint and in places to relay the exposed brickwork of Echo Bridge on the Sudbury Aqueduct. The sodding upon the embankments of this aqueduct and of the Weston and Cochituate aqueducts has been improved, and considerable fencing has been erected along the latter to protect the lands of the Commonwealth.

### (5) PUMPING STATIONS.

The pumping stations maintained by the Board are the high-service and low-service pumping stations at Chestnut Hill, the Spot Pond pumping station, the Arlington pumping station and the West Roxbury pumping station. By the introduction of water for the supply of the District through the Weston Aqueduct by gravity the pumping of 25 per cent. of the entire quantity of the water consumed has been saved. All of the remainder of the water furnished, which is supplied through the Sudbury and Cochituate aqueducts, is pumped at either the high or low service station at Chestnut Hill. The total quantity pumped at the two Chestnut Hill stations has been 32,618,420,000 gallons, which is 8.4 per cent. less than that pumped by the two stations during the preceding year. The water is received at Spot Pond by pumping from the Chestnut Hill station, and from the Spot Pond station as well as from the Arlington and West Roxbury stations water is pumped into the higher regions embraced within the District.

The total quantity of water pumped at all the stations during the year was 35,762,190,000 gallons, which was 8.7 per cent. less than the quantity pumped during the preceding year. The total cost of operating all the stations was $[illegible], or $[illegible] per million gallons pumped, — a decrease of $[illegible] from the cost of the preceding year.

The total amount of coal purchased during the year for use at the various stations was [illegible] gross tons. Of this total [illegible] tons were bituminous, [illegible] tons anthracite, [illegible] tons buckwheat anthracite and [illegible] tons were anthracite screenings. The average price per gross ton for the bituminous coal at the several stations varied, chiefly on account of differences in cost of transportation, from $2.96 to $4.22. The average cost of the anthracite coal was $[illegible] per gross ton, of the buckwheat anthracite $2.65, and of the anthracite screenings $2.40.

Under contracts for the purchase of bituminous coal the approximate amounts of thermal units, volatile matter and other constituents required have been specified. In cases where the coal furnished has been inferior to the specifications deductions have been made in the contract price; on the other hand, where coal has been furnished of a superior quality a corresponding increase in payment has been allowed. The result has been that coal of a better quality than last year has been received. For the purpose of such determinations frequent tests of the coal furnished have been required; and in like manner the oils which are furnished for the pumping stations are frequently tested in order to determine whether they are furnished in accordance with the contract.

The cost per million gallons of water raised one foot was, for the Chestnut Hill high-service station, $0.027; for the Chestnut Hill low-service station, $0.037; for the Spot Pond station, $0.040; for the Arlington station, $0.114; and for the West Roxbury station, $0.223. The average cost at all the stations of raising one million gallons of water one foot high has been $0.0349, — which is slightly less than the average cost in the previous year.

As stated in the report of last year, the increased demands for pumping which were put upon the West Roxbury pumping station were such that it was determined necessary to increase the capacity of that station. Accordingly, a small addition was made to the building, and a pumping engine which formerly belonged to the city of Melrose, and was taken by the Board, was put into proper repair and removed to this station. A new boiler was also provided. The repairs of the engine and necessary piping, as well as some other work, were performed by the regular maintenance force. The entire expenditure for the purpose was $5,782.94.

While there has been a decrease of 3,394,430,000 gallons in the total quantity of water pumped at the different stations, this decrease has especially occurred at the Chestnut Hill low-service pumping station, and also at the Spot Pond pumping station, where a large reduction occurred on account of the more general introduction of meters, especially in Melrose and Swampscott.

### (6) Pipe Lines.

The system of mains has increased by 7.88 miles during the past year, making the aggregate maintained by the Board at the end of the year 92.53 miles. The length of the various mains 4 inches and more in diameter, connected with the Metropolitan System, but owned and operated by the several cities and towns through which water was supplied from the Metropolitan Works, was 1,602.62 miles.

Two breaks in the main pipes occurred during the year, both of which caused considerable damage from water to private property. One was in the 48-inch main in Brighton, which was quickly repaired. The more serious one occurred on Christmas Eve in the 48-inch main in Harvard Square in Cambridge, causing the escape of a large quantity of water. This occurred in unfortunate weather, in the latter part of the evening, but was repaired and again in use at midnight of the following day. The injuries to the two mains occasioned the expenditure of a little more than $800; but in the former case the damage to property was small, while the latter case, owing to the character of the buildings flooded, involved a loss of nearly $20,000. In both cases the breaks occurred from causes beyond the control of the Board. In the latter case a claim for reimbursement will be made. There were in addition 31 leaks on the pipe lines from various causes, several of them from defective joints.

The abolition of a grade crossing on the Boston & Maine Railroad in Malden called for a relocation of a 30-inch high-service main about 1,000 feet in length. Though the larger part of the work of relocation was performed by the Board, the expense will ultimately be paid out of the fund for abolishing grade crossings.

### (8) PROTECTION OF THE WATER SUPPLY.

For the protection of the water supply there are maintained several systems of filter-beds designed to purify the surface water flowing from various thickly populated districts before it is admitted into the storage reservoirs.

The Pegan filter-beds receive the drainage of a considerable portion of the thickly settled district of Natick and some of the outlying regions, this drainage being collected by ditches in a basin and then pumped upon the filter-beds before entering Lake Cochituate. There was a daily average of 689,310 gallons pumped upon the beds during the year and the pumps were in operation on 174 days. The cost of operating the pumping station and maintaining the filter-beds amounted to $10.36 per million gallons treated.

The Marlborough Brook filter-beds receive the surface drainage from a portion of the thickly settled district of the city of Marlborough before its admission into the Sudbury Reservoir. No pumping station is required for elevating the surface water. The beds were sufficient to filter all the water of Marlborough Brook before it entered the reservoir, except for a few days when there were slight overflows during freshets.

The Sterling filter-beds receive the drainage of the village of Sterling and no pumping station is required. These beds have been in continuous operation during the year and have been effectual for providing for the entire amount of surface water, except during one heavy rain. Some repairs and reinforcements have been required in these during the past year.

Other small filter-beds which have been operated receive the drainage from cottages at Sterling Junction during the warmer season, and others are operated for the disposal of the drainage from the Worcester County Training School at Oakdale.

No extension has been made of the drainage ditches, having a length of 36.36 miles, which have been constructed in the swamps upon the different watersheds for the purpose of improving the character of the water which flows from the swamps into the reservoirs. Constant work has been required for keeping the ditches in proper condition, and various improvements have been made in those existing.

Though the cutting of ice is permitted, upon written application, on Framingham reservoirs Nos. 2 and 3, upon the Sudbury and Whitehall reservoirs and upon Dudley and Waushacum ponds, measures are taken in all cases that the work shall be so done as not in any manner to pollute the water. Notice of the time and place of the cutting proposed is in all cases required, and agents of the Board are detailed to inspect and supervise the work. For these services a fee not exceeding $5 a day is imposed, but this fee may be divided between various parties who are doing the work at the same time and at places in the same vicinity.

A biological laboratory is maintained by the Board for the microscopical and biological examinations of the water in the various sources of supply. The water of the various reservoirs is examined as to color, taste, odor and turbidity as often as once each week and a monthly examination is regularly made of the water of the various main feeders of the water system. Constant biological examination is also made in the laboratory of water taken from the various sources of supply. Special examinations are made wherever water is peculiarly affected by microscopic organisms. During the year 2,471 microscopical and 1,072 biological examinations of the water collected at as many as 43 different places were made. Samples of water collected from the storage and distributing reservoirs and their various feeders, taken from 29 different points, are sent at monthly or semi-monthly intervals to the State Board of Health for chemical analysis. By means of these examinations the Board is enabled to draw the supply from such sources as are most free from objectionable organisms or disturbing influences, and also enabled to take any measures which may be possible for the improvement of the waters affected.

Various means have been adopted during the past year for the protection of the waters of Lake Cochituate, as elsewhere described. The Board determined that no permission should be given for boating on Lake Cochituate during the year. Although the waters and margins of the lake had been taken by the city of Boston as long ago as the year 1846 as a source of supply for that city, and reimbursement in damages had been made to all whose rights had been taken, boating had continued to be permitted as previously practiced. After the taking of the waters of the lake in the year 1898 the Board was reluctant so long as possible to interfere with the privileges enjoyed by the people, and suffered boating to be continued and the people to cross the marginal lands of the Commonwealth, although boating was prohibited on all the other reservoirs so closely connected with the District's water supply.

The increasing number of small cottages about the lake, the occupancy of the marginal lands for camping, the offering of the nearby lands for building and for club and picnic purposes and for summer resorts, all accompanied by an increase of boating, compelled the Board in 1906, in order to keep the water suitable for use as a water supply, to close against boating the northern section of the lake, from which is the direct outlet into the aqueduct, and to restrict the use by the public of the middle and southern sections of the lake. During the years 1906, 1907 and 1908 a limited number, composed practically of residents of the towns in which the lake is situated, were thus permitted the use of boats under inspection and regulation. These measures, however, were but in part effective, and, moreover, much attention of the public was drawn to the dangers threatening the water supply from the practice. A larger measure of protection of water supplies is demanded from year to year by the general public, and greater attention has been called to the menaces which arise from the practice of boating upon waters used for water supply. In a considerable number of the larger systems of water supply elsewhere boating upon reservoirs is altogether prohibited.

After much consideration and upon advice of those deemed best qualified to judge, the Board determined early in the present year that on account of the possible dangers of pollution to the water supply of the Metropolitan District it would not longer be justified in permitting the recreation of boating upon the lake whose waters had been thus acquired and devoted to the purposes of a water supply.

Although the Cochituate watershed is more exposed to pollution than other watersheds on account of the larger resident population, the works are an indispensable part of the Metropolitan System of supply. During the past year water has been drawn for the use of the Metropolitan District during a total period of about four months, and the daily average for the entire year has amounted to more than two-thirds of the total daily capacity of the lake.

The gradual improvements which have been made in the sanitary conditions of the surroundings of the lake now cause the waters to be better protected from actual and threatening dangers of pollution than ever before, and the other improvements which are in progress will, it is believed, cause the lake to remain a valuable source of water supply for years to come.

Through a recommendation made by the Board an Act was passed by the Legislature of the year 1909 by which it was provided that the Board might close and terminate the existing connection between Lake Cochituate and Dug Pond in the town of Natick, and transfer and release to that town all interest in and control over the waters of Dug Pond, it being provided that thereafter the pond should not be used as a source of water supply for the Metropolitan District or allowed to overflow into Lake Cochituate. This pond has an area exceeding 50 acres, and its shores had already been acquired by the town for a public park. Its situation was such that it was especially difficult to provide for the protection of its waters against pollution, and its surroundings and central situation were such as to offer to the residents of Natick attractive opportunities for boating and other like privileges. The Board made a release of its interest and control over the waters of the pond to the town of Natick which was accepted by the town. The connections between the pond and Lake Cochituate were closed in the month of July, and an outlet was made for the waters of the pond into the watershed of the Charles River.

A force, varying according to the different seasons from 3 to 15 men, has been employed to patrol the margins of the several reservoirs, and, in cases, the waters of the reservoirs, for the purpose of enforcing the regulations of the Board relative to boating, fishing, hunting and other menaces to the water, as well as the property of the Commonwealth. This protection has been particularly required upon the grounds surrounding the Chestnut Hill Reservoir where large numbers congregate on evenings and especially on Sundays and holidays. The opening of the electric car service to Spot Pond during the past season caused large numbers of people to resort to the shores of the pond, and especial vigilance was required in order to protect them and prevent the pollution of the water.

A considerable number of persons have been found violating the rules and regulations of the Board. Some men and boys were discovered bathing in the reservoirs, and five have been called before the court and two of them have been fined. Forty-eight persons have been detected violating the regulations pertaining to fishing. Eleven of these were summoned into court, of whom six were fined.

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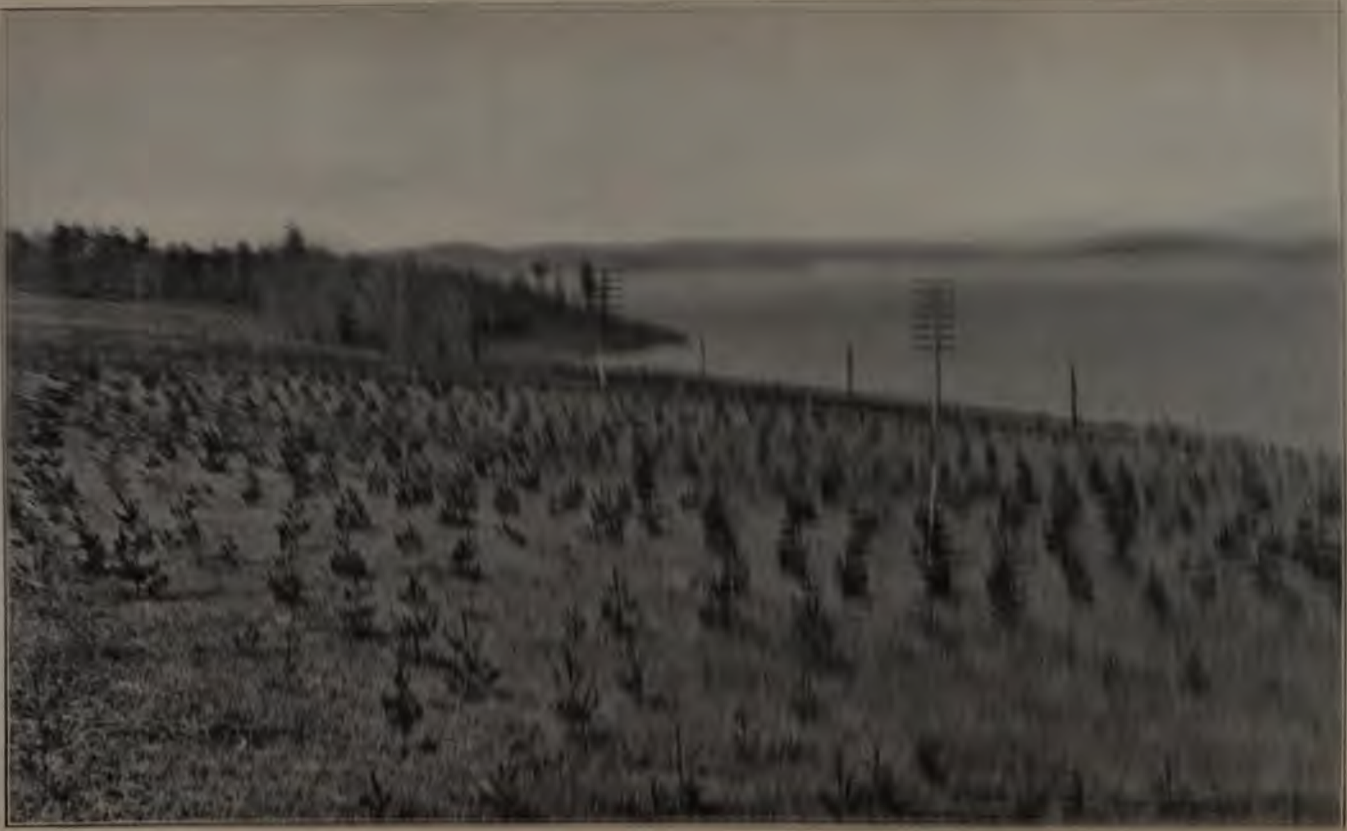


WACHUSETT RESERVOIR — Seven-year-old WHITE PINES in Grass Land.

### (9) SANITARY INSPECTION.

A constant inspection of the watersheds has been maintained during the past year by William W. Locke, C. E., who has had the help of two assistants.

On the Sudbury and Cochituate watersheds 19 cases of typhoid fever were reported during the year. Precautions were taken by the sanitary inspectors in all cases to protect the water supply from pollution, and so far as known no harmful results have followed.

During the year there have been reported on the Wachusett watershed 9 cases of typhoid fever and 1 of dysentery, these all occurring in the town of Holden. All of these with the exception of 2 cases occurred in houses not supplied with water from a public water supply. The 2 cases excepted were at the Mt. Pleasant Hotel, from which originated an epidemic of typhoid fever resulting in 59 cases and 8 deaths, all of which cases, with the exception of the 2 mentioned, developed outside of the watershed. The epidemic was ascribed to a contamination of milk which had been supplied.

Premises upon the watersheds have been inspected during the year for the purpose of ascertaining the number and condition of sewer connections and cesspools, and also the condition of privies, sink drainage, manufacturing wastes and other disturbing elements. Upon the Wachusett watershed there were inspected during the year 1,475 premises. During the year 7 new cesspools have been constructed, and under the requirements 16 new buildings, built upon the watershed, have been provided with cesspools. The sanitary condition of the watershed has been further improved by the removal of 4 buildings which were standing upon the territory belonging to the Commonwealth. The number of cases inspected upon the Sudbury and Cochituate watersheds was 7,083. Upon the Sudbury watershed 44 old and 14 new premises were connected with public sewers, and upon the Cochituate watershed 33 old and 29 new premises were so connected.

### (10) FORESTRY.

The Board is obliged to exercise a care over more than 15.5 square miles of land, the larger part of which is covered with trees. Not only has considerable forestry work been done for the care and improvement of tracts of existing woodland, but also a large portion of the cleared lands, particularly those directly about the reservoirs, has been planted with trees. On the margins of the Wachusett Reservoir, a total area of 1,341 acres has been planted, and of this aggregate 27.5 acres have been planted during the past year. This planting has been principally of white pine seedlings. Besides, areas covered more or less with woods have been improved by the thinning out of the trees and the removal of brush. Tree planting and improvement have also been effected in some of the outlying lands belonging to the Board, and particularly upon the highways through lands of the Board and on the forest roads through these lands.

For the protection of the marginal lands a fire patrol has been found necessary, but, notwithstanding the precautions which have been taken, three fires of considerable extent have taken place during the year in which large areas have been burned over, and considerable damage has been done in the destruction of the newly planted trees.

During the year there were used for planting on the Wachusett watershed 36,000 white pines, and 34,050 arbor vitæ and maple seedlings were transplanted from the nursery to the margins of the highways.

In the Lamson nursery on the north side of the reservoir there are 58,100 arbor vitæ and a considerable number of sugar maples, locusts, white oaks, ashes and walnuts.

The Flagg nursery is maintained upon the south side of the reservoir and now contains 23,350 white pines and 19,350 arbor vitæ.

Considerable forestry work has also been done on the margins of the Sudbury Reservoir, where 5,000 white pines have been planted during the past year and where brush and undesirable trees have been removed, and other areas have been improved by cutting. Some tree planting has been accomplished about the Ashland and Hopkinton reservoirs, and other work has been done around Lake Cochituate and along the Sudbury and Cochituate aqueducts in the cutting out of underbrush and the removal of undesirable trees.

### (11) MOTH SUPPRESSION.

Much work has been required during the past year to prevent the depredations not only of the gypsy and brown-tail moths but of the elm-leaf beetle and the pine-tree weevil, and the amount which has been expended on different regions under the control of the Board has been a little in excess of that of last year, the total expenditure having amounted to $8,012.28.

Nearly one-half of the amount expended was spent in the region about Spot Pond, where it was necessary again to attack the egg clusters of the gypsy moths and to spray the trees upon considerable areas. Much of the work was required in the southern part of the territory on the line between the Commonwealth's land and that of the city of Medford. There has been an increase in the number of gypsy moths about the Chestnut Hill Reservoir and also at Lake Cochituate. The brown-tail moths have largely increased in the regions about the Sudbury Reservoir and they have also been found along the open channel of the Wachusett Aqueduct, about the Wachusett Dam and at the upper end of the Wachusett Reservoir in West Boylston and Oakdale, as well as in the grounds about the Clinton sewerage filter-beds.

The pine-tree weevil has severely attacked the young pines which have been set out by the Board so that it has been necessary to cut off and burn many of the affected shoots. The trouble has arisen among the pines both about the Wachusett Reservoir and the Sudbury Reservoir, affecting in different localities from one in three to one in twenty-five.

Less trouble has been caused by the elm-leaf beetle than in the preceding year.

The efforts which have been made for the protection of the trees would have been sufficient to keep them from serious injury had there been similar effort on the part of those in ownership and control of neighboring lands.

## (12) Quality of the Water.

According to the chemical examinations of the water made in the laboratory of the State Board of Health during the past year the water supplied to the Metropolitan District has been superior in quality in most of the important elements to that of the preceding year. In the early part of the year, however, it was much affected in odor and taste by the presence of organisms which, though objectionable, were not injurious to health. One of these organisms, known as Asterionella, reached an unexpected and extraordinary development in the Wachusett Reservoir, and the numbers of these increased so greatly that they affected the water disagreeably and

[illegible]

[illegible]

[illegible]

The yield of water or the amount of water collected on the various watersheds does not necessarily correspond closely with the rainfall, as the proportion of the rainfall which reaches the reservoirs varies according to circumstances prevailing from time to time. The percentage of rainfall collected on the Wachusett watershed was 43.3 per cent, on the Sudbury watershed [illegible] per cent, and on the Cochituate watershed [illegible] per cent, of the entire rainfall.

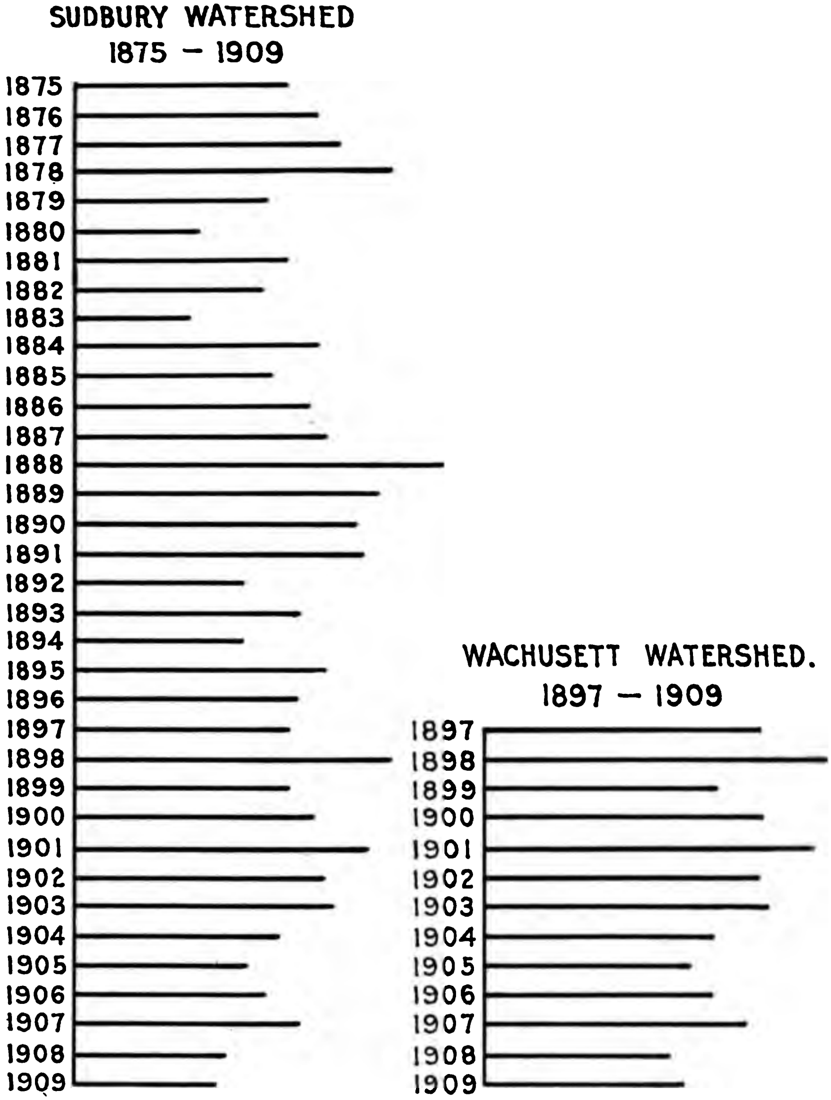
The amount of water collected on the Wachusett watershed in the year [illegible] was only [illegible] of the average amount for the years since the measurements have been made, and the amount so collected on the Sudbury watershed was but 0.60 of the average.

The measurements on the Wachusett watershed begin with the year [illegible], but on the Sudbury watershed they began to be recorded in the year [illegible].

The unusually small amount of water yielded during the past six years, five of which have been peculiarly dry, is indicated by the accompanying diagrams, showing the comparative amounts collected in the successive years in the Wachusett and Sudbury watersheds.

The average daily quantity of water furnished by the various sources of supply as determined by measurements at the pumping

# COMPARATIVE AMOUNTS OF WATER COLLECTED IN THE DIFFERENT YEARS ON THE SUDBURY AND WACHUSETT WATERSHEDS PER SQUARE MILE OF WATERSHED.



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[illegible]
[illegible]

stations and of the flow through the Weston Aqueduct, and including the estimated yield of Spot Pond, was 119,386,000 gallons, as against a daily average of 127,301,000 gallons during the preceding year.

## VI. WATER WORKS — FINANCIAL STATEMENT.

The financial abstract of the receipts, disbursements, assets and liabilities of the Board for the State fiscal year, beginning with December 1, 1908, and ending with November 30, 1909, was, in accordance with the requirements of chapter 255 of the Acts of the year 1906, presented to the General Court in January last, and a copy of this financial abstract is printed as Appendix No. 7.

The more detailed statement of its doings required by said chapter, for the calendar year 1909, in relation to the Metropolitan Water Works, is herewith presented.

The Metropolitan Water Loans authorized for the construction and acquisition of works have amounted to $41,798,000. To this sum are added the proceeds from the sale of certain property by the Board, and these amounted on January 1, 1910, to $257,071.66. The total amount, therefore, which the Board has been authorized to expend is $42,055,071.66. The amount of expenditures approved by the Board for payment out of the Metropolitan Water Loan Fund was, for the year 1909, $359,667.13, and the total amount so approved for payment since the beginning of the work up to January 1, 1910, has been $41,044,304.64. There was accordingly a balance remaining at the beginning of the year 1910 amounting to $1,010,767.02.

The Treasurer of the Commonwealth has issued from time to time, on the request of the Board, bonds to the amount of $40,898,000. These bonds were issued for terms of thirty-nine and one-half and forty years from the date of issue, and bear interest at the rate of 3 per cent. and 3½ per cent. per annum. The sinking fund established for the payment of the bonds at maturity amounted on January 1, 1910, to $7,226,262.31.

The increase in the debt, during the calendar year, as represented by the Metropolitan Water Loans outstanding, was $398,000. The increase of the sinking fund for the payment of the debt at maturity was, during the same period, $806,979.03. There has been, therefore, a decrease of the net debt during the calendar year amounting to $408,979.03.

The amount approved by the Board for the maintenance and operation of the Water Works for the year 1909, which was paid out of the annual assessments, was $397,166.41.

The assessments for the year 1909, for the payment of interest on the bonds, for the sinking fund requirements and for the expenses of operation and maintenance of the Water Works, which were levied upon the various cities and towns in the Metropolitan District, amounted to $2,360,748.28.

The detailed financial statement regarding the Metropolitan Water Works is as follows: —

### (1.) METROPOLITAN WATER LOANS, RECEIPTS AND PAYMENTS.

The loans authorized for the construction and acquisition of the Metropolitan Water Works, the receipts which are added to the proceeds of these loans, the expenditures for the construction and acquisition of works, and the balance available on January 1, 1910, have been as follows: —

| | | |
|---|---|---|
| *Loan under chapter 488 of the Acts of 1895,* | | $27,000,000 00 |
| *Loan under chapter 453 of the Acts of 1901,* | | 13,000,000 00 |
| *Loan under chapter 367 of the Acts of 1906,* | | 500,000 00 |
| *Loan under chapter 568 of the Acts of 1908,* | | 398,000 00 |
| *Loan under chapter 320 of the Acts of 1909,* | | 900,000 00 |
| | | $41,798,000 00 |
| *Receipts from the sales of property applicable to the construction and acquisition of works:* — | | |
| *For the year ending December 31, 1909,* | $4,504 79 | |
| *For the period prior to January 1, 1909,* | 162,566 87 | |
| | | 167,071 66 |
| *Receipt from town of Swampscott for admission to the Metropolitan Water District paid into Loan Fund (St. 1909, c. 320),* | | 90,000 00 |
| | | $42,055,071 66 |
| *Amount approved by the Metropolitan Water and Sewerage Board for payments out of the Water Loan Fund:* — | | |
| *For the year ending December 31, 1909,* | $359,667 13 | |
| *For the period prior to January 1, 1909,* | 40,684,637 51 | |
| | | 41,044,304 64 |
| *Balance January 1, 1910,* | | $1,010,767 02 |

## (2) ISSUES OF METROPOLITAN WATER LOAN BONDS.

The Treasurer of the Commonwealth, under the authority given him to issue from time to time, on the request of the Board, negotiable bonds to an amount not exceeding $41,798,000, to be designated the "Metropolitan Water Loan," has sold bonds as follows: —

| DATE OF SALE. | Amount of Bonds sold. | Rate of Interest (Per Cent.). | Price received. | Date due. | Premium. |
|---|---|---|---|---|---|
| Sept. 25, 1895, . . . . . . | $5,000,000 | 3½ | 110.67 | July 1, 1935 | $533,500 00 |
| Nov. 23, 1896, . . . . . . | 2,000,000 | 3½ | 106.76288 | July 1, 1935 | 135,253 60[1] |
| Feb. 8, 1897, . . . . . . | 6,000,000 | 3½ | 107.82 | July 1, 1935 | 469,200 00 |
| Jan. 13, 1898, . . . . . . | 2,000,000 | 3½ | 113 176 | Jan. 1, 1938 | 263,520 00 |
| Mar. 2, 1898, . . . . . . | 2,000,000 | 3½ | 112.877 | Jan. 1, 1938 | 257,540 00 |
| June 15, 1899, . . . . . . | 3,000,000 | 3 | 100.64 | July 1, 1939 | 19,200 00 |
| June 28, 1900, . . . . . . | 1,000,000 | 3 | 102.78 | July 1, 1939 | 27,800 00 |
| Mar. 5, 1901, . . . . . . | 3,000,000 | 3 | 102.155 | Jan. 1, 1941 | 64,650 00 |
| July 24, 1901, . . . . . . | 100,000 | 3 | 100.375 | Jan. 1, 1941 | 375 00 |
| July 24, 1901, . . . . . . | 150,000 | 3 | 100.10 | Jan. 1, 1941 | 150 00 |
| July 30, 1901, . . . . . . | 205,000 | 3 | 100.25 | Jan. 1, 1941 | 512 50 |
| July 31, 1901, . . . . . . | 50,000 | 3 | 100.25 | Jan. 1, 1941 | 125 00 |
| Aug. 7, 1901, . . . . . . | 50,000 | 3 | 100.50 | Jan. 1, 1941 | 250 00 |
| Aug. 8, 1901, . . . . . . | 300,000 | 3 | 100.10 | Jan. 1, 1941 | 300 00 |
| Aug. 8, 1901, . . . . . . | 200,000 | 3 | 100.25 | Jan. 1, 1941 | 500 00 |
| Sept. 17, 1901, . . . . . . | 3,100,000 | 3½ | 106.71 | Jan. 1, 1941 | 208,010 00 |
| Oct. 1, 1901, . . . . . . | 1,345,000 | 3 | 100. | Jan. 1, 1941 | - |
| Oct. 24, 1901, . . . . . . | 1,500,000 | 3 | 100. | Jan. 1, 1941 | - |
| Feb. 26, 1902, . . . . . . | 500,000 | 3½ | 109.13 | Jan. 1, 1942 | 45,650 00 |
| Feb. 26, 1902, . . . . . . | 3,000,000 | 3½ | 109.13 | Jan. 1, 1942 | 273,900 00 |
| April 7, 1903, . . . . . . | 250,000 | 3½ | 106.725 | Jan. 1, 1943 | 16,812 50 |
| April 17, 1903, . . . . . . | 1,250,000 | 3½ | 106.1329 | Jan. 1, 1943 | 76,661 25 |
| Jan. 15, 1904, . . . . . . | 500,000 | 3½ | 104.60 | Jan. 1, 1943 | 23,000 00 |
| Jan. 15, 1904, . . . . . . | 2,000,000 | 3½ | 104.60 | Jan. 1, 1944 | 92,000 00 |
| Mar. 24, 1905, . . . . . . | 650,000 | 3½ | 105.761 | Jan. 1, 1945 | 37,446 50 |
| June 28, 1906, . . . . . . | 943,000 | 3½ | 103.09 | Jan. 1, 1946 | 29,138 70 |
| June 28, 1906, . . . . . . | 100,000 | 3½ | 103.09[2] | Jan. 1, 1946 | 3,090 00 |
| June 28, 1906, . . . . . . | 307,000 | 3½ | 103.09[2] | Jan. 1, 1946 | 9,486 30 |
| Mar. 17, 1909, . . . . . . | 398,000 | 3½ | 101.16[6] | Jan. 1, 1949 | 4,760 08 |
| | $40,898,000 | | | | $2,592,831 43 |

---

[1] Including $18,673.60 from readjustment of rate made by the Treasurer in 1897.

[2] Not issued or delivered until 1907.

Prior to May 1, 1906, all premiums received from the sales of bonds were applied to the payment of the current charges in reduction of the annual assessments, but since that date, under the provisions of chapter 337, Acts of 1906, they have been paid into the sinking fund.

### (3) Metropolitan Water Loan Sinking Fund.

The sinking fund established by the Treasurer of the Commonwealth has amounted at the end of each year to sums as follows: —

| | | | |
|---|---|---|---|
| December 31, 1895, . | $226,286 05 | December 31, 1903, . | $2,877,835 59 |
| December 31, 1896, . | 699,860 70 | December 31, 1904, . | 3,519,602 92 |
| December 31, 1897, . | 954,469 00 | December 31, 1905, . | 4,207,045 69 |
| December 31, 1898, . | 1,416,374 29 | December 31, 1906, . | 4,897,822 62 |
| December 31, 1899, . | 1,349,332 97 | December 31, 1907, . | 5,643,575 69 |
| December 31, 1900, . | 1,573,619 72 | December 31, 1908, . | 6,419,283 28 |
| December 31, 1901, . | 1,662,426 95 | December 31, 1909, . | 7,226,262 31 |
| December 31, 1902, . | 2,256,803 81 | | |

### (4) Annual Assessments and Receipts.

Assessments for the year, amounting to $2,360,746.28, were required for the payment of the interest on the bonds issued by the Commonwealth, the sinking fund requirements and the expenses of operation and maintenance of the Water Works. The requirements were: for interest, $1,395,403.49; for the sinking fund, $520,331.43; and for maintenance and operation, $445,011.36. These assessments were made by the Treasurer of the Commonwealth upon the various municipalities as follows: —

| | | | |
|---|---|---|---|
| Arlington, . . . . | $17,442 46 | Malden, . . . . | $39,350 16 |
| Belmont, . . . | 7,461 96 | Medford, . . . | 36,752 69 |
| Boston, . . . | 1,862,823 42 | Melrose, . . . | 24,523 38 |
| Chelsea, . . . | 51,499 13 | Milton, . . . | 15,455 71 |
| Everett, . . . | 44,833 29 | Nahant, . . . | 4,566 73 |
| Hyde Park, . . | 1,327 03 | Newton, . . . | 6,524 98 |
| Lexington, . . . | 7,384 17 | Quincy, . . . | 51,230 04 |

| | | | |
|---|---|---|---|
| Revere, . . . | $23,140 55 | Watertown, . . . | $15,758 18 |
| Somerville, . . . | 112,573 20 | Winthrop, . . . | 16,744 76 |
| Stoneham, . . . | 10,234 41 | | |
| Swampscott, . . | 11,120 03 | | $2,380,746 28 |

The comparatively smaller sums assessed upon the city of Newton and the town of Hyde Park were owing to the fact that neither of these municipalities had reached the safe capacity of its own sources of water supply, and neither had been furnished with water.

The proceeds from the operations of the Board, exclusive of the proceeds from sales of property and of water, are required by statute to be applied to the payment of the interest, the sinking fund requirements and expenses of maintenance and operation of works. These for the year 1909 amounted to $6,210.94.

The amount approved by the Board for the maintenance and operation of the Metropolitan Water Works was, for the year 1909, $397,166.41.

### (5) SUPPLYING WATER TO CITIES AND TOWNS OUTSIDE OF DISTRICT AND TO WATER COMPANIES.

Sums have been received during the year 1909, under the provisions of the Metropolitan Water Act, for water furnished, as follows: —

| | |
|---|---|
| Town of Framingham, . . . . . . . . . . . | $313 34 |
| United States Government, . . . . . . . . . . | 1,086 83 |
| | $2,300 17 |

The sums so received, prior to March 23, 1907, were annually distributed among the cities and towns of the District, but since that date, in accordance with the provisions of chapter 238 of the Acts of 1907, the sums so received have been paid into the sinking fund.

## [illegible] Expenditures on the Different Works.

The following is a summary of the expenditures [illegible] for the different works: —

| [illegible] | For the Year ending December 31, [illegible]. | | From Beginning of Work to December 31, [illegible]. | |
|---|---|---|---|---|
| [illegible] | | [illegible] | | [illegible] |
| [illegible] | | | | |
| [illegible] | [illegible] | | [illegible] | |
| [illegible] | [illegible] | | [illegible] | |
| [illegible] | [illegible] | | [illegible] | |
| [illegible] | [illegible] | | [illegible] | |
| [illegible] | [illegible] | | [illegible] | |
| [illegible] | [illegible] | | [illegible] | |
| [illegible] | [illegible] | | [illegible] | |
| [illegible] | [illegible] | | [illegible] | |
| [illegible] | [illegible] | | [illegible] | |
| Other expenses, | - | | [illegible] | |
| | | [illegible] | | [illegible] |
| Improving Wachusett watershed, | | [illegible] | | [illegible] |
| Wachusett Aqueduct, | | [illegible] | | [illegible] |
| Sudbury Reservoir, | | - | | 2,923,133 71 |
| Protection of Sudbury supply, | | - | | 129,198 36 |
| Improving Sudbury watershed, | | 222 00 | | 95,711 84 |
| Protection of Cochituate supply, | | - | | 9,088 08 |
| Improving Cochituate watershed, | | - | | 8,388 66 |
| Improving Lake Cochituate, | | 4 00 | | 104,141 29 |
| Pipe lines, [illegible] No. [illegible] to [illegible] No. 1, | | - | | 48,471 48 |
| Pipe line, Rosemary siphon, | | - | | 23,142 98 |
| Weston Aqueduct: | | | | |
| Aqueduct, | $1,627 35 | | $2,353,820 11 | |
| Reservoir, | - | | 289,091 82 | |
| Real estate, taxes and other expenses, | - | | 206,668 18 | |
| | | 1,627 35 | | 2,849,580 11 |
| Distribution system: | | | | |
| Low service: | | | | |
| New 48-inch main, Section 31, | $98,128 79 | | $162,698 06 | |
| Pipe lines and connections, | 135 25 | | 1,753,027 25 | |
| Pumping station, Chestnut Hill, | - | | 462,572 19 | |
| Reservoir, Spot Pond, | - | | 582,188 73 | |
| Gate house and connections, Chestnut Hill Reservoir, | - | | 65,480 88 | |
| Real estate and other expenses, | - | | 91,725 56 | |
| Amounts carried forward, | $98,264 04 | $20,898 93 | $3,117,692 67 | $19,520,390 39 |

| CONSTRUCTION AND ACQUISITION OF WORKS. | For the Year ending December 31, 1909. | | From Beginning of Work to December 31, 1909. | |
|---|---|---|---|---|
| *Amounts brought forward,* | $98,264 04 | $20,898 93 | $3,117,692 67 | $19,520,390 39 |
| Distribution system — *Concluded.* | | | | |
| Northern high service: — | | | | |
| Pipe lines and connections, | 64,333 00 | | 504,908 26 | |
| Spot Pond pumping station, | - | | 291,829 35 | |
| Fells Reservoir, Stoneham, | - | | 141,392 94 | |
| Bear Hill Reservoir, Stoneham, | - | | 38,267 70 | |
| Real estate and other expenses, | - | | 14,838 05 | |
| Southern high service: — | | | | |
| Pipe lines and connections, | 50 89 | | 515,860 94 | |
| Pumping station, Chestnut Hill, | 70 89 | | 247,152 38 | |
| Forbes Hill Reservoir, Quincy, | - | | 90,003 49 | |
| Waban Hill Reservoir, Newton, | - | | 61,592 11 | |
| Real estate and other expenses, | - | | 10,226 36 | |
| Northern extra high service, | 8,237 62 | | 90,955 06 | |
| Southern extra high service, | 24 60 | | 22,855 27 | |
| Weston Aqueduct supply mains, | 96,212 70 | | 683,754 14 | |
| Meters and connections, | 3,875 02 | | 82,445 58 | |
| Improving Spot Pond Brook, | - | | 3,991 23 | |
| Glenwood pipe yard, | - | | 33,100 59 | |
| Chestnut Hill pipe yard, | - | | 11,311 26 | |
| | | 271,068 76 | | 5,962,177 38 |
| Stock — pipes, valves, castings, etc., purchased and sent first to storage yards, and later transferred, as needed, to the various parts of the work: — | | | | |
| Amount received, | $178,616 83 | | $2,271,979 74 | |
| Transferred from storage yards to the various sections of the work and included in costs of special works, | 111,168 39 | | 2,134,144 16 | |
| | | 67,448 44 | | 137,835 58 |
| Diversion of water, South Branch of Nashua River,[1] | | 251 00 | | 1,363,935 31 |
| Acquisition of existing water works: — | | | | |
| Reimbursement city of Boston, partially constructed Reservoir, | - | | $1,157,921 59 | |
| Boston water works, taken January 1, 1898, | - | | 12,768,948 80 | |
| Spot Pond taken from Malden, Medford and Melrose, | - | | 1,240,229 62 | |
| Waban Hill Reservoir purchased from Newton, | - | | 60,000 00 | |
| Expenses: — | | | | |
| Engineering, $22,617 52 | | | | |
| Conveyancing, 3,862 92 | | | | |
| Legal, expert and court, 46,648 03 | | | | |
| | | | 73,128 47 | |
| *Amounts carried forward,* | . . . | $359,667 13 | $15,300,228 48 | $26,984,338 66 |

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[1] Of the total expenditures from the beginning of the work, the sum of $150,939.89 is for Clinton sewerage system.

| Construction and Acquisition of Works. | | For the Year ending December 31, 1909. | From Beginning of Work to December 31, 1909. | |
|---|---|---|---|---|
| *Amounts brought forward,* | | [illegible] | [illegible] | [illegible] |
| Deduct following, transferred and charged to special works: — | | | | |
| Reimbursement city of Boston, transferred to Sudbury Reservoir, . | [illegible] 19 | | | |
| Waban Hill Reservoir transferred to Distribution Department, . | [illegible] | | | |
| Stock — pipes, engines, etc., included with Boston Water Works and transferred to Distribution Department, . . . | 22,240 91 | | | |
| | | | 1,2[illegible],282 59 | |
| | | | | $14,059,985 98 |
| Total for construction and acquisition of works, . . . | | $859,687 13 | | $41,044,304 64 |

| Maintenance and Operation. | For the Year ending December 31, 1909. | |
|---|---|---|
| Administration, | | $10,147 89 |
| General supervision, | | 30,685 37 |
| Taxes and other expenses, | | 36,450 10 |
| Wachusett Reservoir Department: — | | |
| Superintendence, | $6,224 72 | |
| Reservoir, | 8,986 39 | |
| Forestry, | 7,657 42 | |
| Protection of supply, | 3,604 92 | |
| Buildings and grounds, | 3,461 58 | |
| Wachusett Dam, | 4,605 00 | |
| Wachusett Aqueduct, | 3,476 97 | |
| Clinton sewerage system: — | | |
| Pumping station, | 3,306 49 | |
| Sewers, screens and filter-beds, | 11,565 45 | |
| Sanitary inspection, | 1,699 82 | |
| Swamp drainage, | 1,665 41 | |
| | | 56,254 17 |
| Sudbury Department: — | | |
| Superintendence, Framingham office, | $7,343 05 | |
| Ashland Reservoir, | 1,736 07 | |
| Hopkinton Reservoir, | 2,162 54 | |
| Whitehall Reservoir, | 408 47 | |
| Framingham Reservoirs Nos. 1, 2 and 3, | 6,115 11 | |
| Sudbury Reservoir, | 7,345 72 | |
| Lake Cochituate, | 10,849 83 | |
| Marlborough Brook filters, | 2,109 69 | |
| Pegan filters, | 2,876 18 | |
| *Amounts carried forward,* | $40,946 66 | $133,537 53 |

| MAINTENANCE AND OPERATION. | For the Year ending December 31, 1909. | |
|---|---|---|
| *Amounts brought forward*, | $40,946 66 | $133,537 53 |
| Sudbury Department — *Con.* | | |
| Sudbury and Cochituate watersheds, | 3,063 19 | |
| Sanitary inspection, | 2,958 13 | |
| Cochituate Aqueduct, | 4,224 14 | |
| Sudbury Aqueduct, | 10,390 08 | |
| Weston Aqueduct, | 4,880 29 | |
| Improving Lake Cochituate, | 423 90 | |
| | | 66,886 39 |
| Distribution Department: — | | |
| Superintendence, | $4,689 14 | |
| Arlington pumping station, pumping service, | 7,844 17 | |
| Chestnut Hill low-service pumping station, pumping service, | 33,012 64 | |
| Chestnut Hill high-service pumping station, pumping service, | 50,655 48 | |
| Spot Pond pumping station, pumping service, | 13,650 68 | |
| West Roxbury pumping station, pumping service, | 12,976 25 | |
| Arlington standpipe, | 43 67 | |
| Bear Hill Reservoir, | 155 25 | |
| Chestnut Hill Reservoir and grounds, | 10,476 73 | |
| Fells Reservoir, | 460 54 | |
| Forbes Hill Reservoir, | 908 12 | |
| Mystic Lake, conduit and pumping station, | 1,097 19 | |
| Mystic Reservoir, | 1,028 10 | |
| Waban Hill Reservoir, | 265 25 | |
| Weston Reservoir, | 2,380 65 | |
| Spot Pond, | 8,036 67 | |
| Buildings at Spot Pond, | 304 07 | |
| Pipe lines: — | | |
| Low service, | 20,201 04 | |
| Northern high service, | 4,548 06 | |
| Southern high service, | 3,248 40 | |
| Supply pipe lines, | 566 37 | |
| Buildings at Chestnut Hill Reservoir, | 3,060 66 | |
| Chestnut Hill pipe yard, | 911 21 | |
| Glenwood pipe yard and buildings, | 3,567 05 | |
| Stables, | 9,478 44 | |
| Waste prevention, | 16 00 | |
| Venturi meters, | 2,043 97 | |
| Measurement of water, | 942 64 | |
| Arlington pumping station, buildings and grounds, | 174 05 | |
| | | 196,742 49 |
| Total for maintaining and operating works, | | $397,166 41 |

## V. DETAILED FINANCIAL STATEMENT UNDER METROPOLITAN WATER ACT.

The Board herewith presents, in accordance with the requirements of the Metropolitan Water Act, a detailed statement of the expenditures and disbursements, receipts, assets and liabilities for the year 1909.

### 1. *Expenditures and Disbursements.*

The total amount of the expenditures and disbursements on account of construction and acquisition of works for the year beginning January 1, 1909, and ending December 31, 1909, is $359,567.13, and the total amount from the time of the organization of the Metropolitan Water Board, July 19, 1895, to December 31, 1909, is $41,044,304.64.

For maintenance and operation the expenditures for the year have been $397,166.41, and from the beginning of the work, $3,811,047.26.

The salaries of the commissioners, and other expenses of administration, have been apportioned to the construction of the works and to the maintenance and operation of the same, and appear under each of those headings.

The following is a division of the expenditures according to their general character: —

| GENERAL CHARACTER OF EXPENDITURES. | For the Year ending December 31, 1909. | | From Beginning of Work to December 31, 1909. | |
|---|---|---|---|---|
| CONSTRUCTION OF WORKS AND ACQUISITION BY PURCHASE OR TAKING. | | | | |
| *Administration.* | | | | |
| Commissioners, | $3,500 00 | | $118,476 91 | |
| Secretary and auditor, | 750 00 | | 49,842 03 | |
| Clerks and stenographers, | 1,790 00 | | 60,974 16 | |
| Legal services, | – | | 2,359 00 | |
| Traveling, | 20 00 | | 3,660 89 | |
| Stationery and printing, | 511 21 | | 11,735 17 | |
| Postage, express and telegrams, | 110 00 | | 2,917 17 | |
| Furniture and fixtures, | 2 25 | | 4,283 14 | |
| Alterations and repairs of buildings, | 5 90 | | 5,790 17 | |
| Telephone, lighting, heating, water and care of building, | 294 71 | | 11,697 08 | |
| Rent and taxes, main office, | 242 56 | | 5,182 90 | |
| Miscellaneous expenses, | 39 10 | | 4,534 67 | |
| | | $7,265 73 | | $281,453 29 |
| *Engineering.* | | | | |
| Chief engineer and department engineers, | – | | $207,471 36 | |
| Principal assistant engineers, | $797 79 | | 158,011 30 | |
| Engineering assistants, | 5,988 53 | | 1,038,014 22 | |
| Consulting engineers, | – | | 24,415 07 | |
| Inspectors, | 4,878 38 | | 295,760 51 | |
| Architects, | – | | 36,161 19 | |
| Railroad and street car travel, | 67 36 | | 26,884 62 | |
| Wagon hire, | 39 75 | | 45,337 53 | |
| Stationery and printing, | 282 58 | | 26,418 87 | |
| Postage, express and telegrams, | 82 | | 7,730 00 | |
| Engineering and drafting instruments and tools, | 1 50 | | 19,309 53 | |
| Engineering and drafting supplies, | 28 27 | | 24,990 28 | |
| Books, maps and photographic supplies, | 20 76 | | 6,989 22 | |
| Furniture and fixtures, | – | | 14,978 46 | |
| Alterations and repairs of buildings: — | | | | |
| Main office, | 1 10 | | 14,108 96 | |
| Sub-offices, | – | | 2,939 36 | |
| Telephone, lighting, heating, water and care of buildings: — | | | | |
| Main office, | 884 27 | | 25,757 66 | |
| Sub-offices, | 42 70 | | 19,667 82 | |
| Rent and taxes, main office, | 727 70 | | 15,317 15 | |
| Rent of sub-offices and other buildings, | – | | 4,526 74 | |
| Field offices and sheds, | – | | 1,274 49 | |
| Clinton office building, | – | | 9,866 87 | |
| Unclassified supplies, | 10 69 | | 8,251 22 | |
| Miscellaneous expenses, | 18 72 | | 8,944 99 | |
| | | 13,790 92 | | 2,043,127 42 |
| *Amounts carried forward,* | | $21,056 65 | | $2,324,580 71 |

| GENERAL CHARACTER OF EXPENDITURES. | For the Year ending December 31, 1909. | | From Beginning of Work to December 31, 1909. | |
|---|---|---|---|---|
| *Amounts brought forward,* | | $21,056 65 | | $2,324,580 71 |
| *Construction.* | | | | |
| Preliminary work (borings, test pits and other investigations): — | | | | |
| Advertising, | $116 11 | | $6,458 91 | |
| Other preliminary work as given in detail in preceding annual report, | - | | 155,457 41 | |
| | | 116 11 | | 161,916 32 |
| Contracts, Wachusett Reservoir: — | | | | |
| Contracts completed and final payments made prior to January 1, 1909, | - | | $5,406,738 30 | |
| McBride & Co., Stillwater improvement, | - | | 23,314 67 | |
| Sundry bills paid under this contract, | $75 51 | | 3,552 11 | |
| | | 75 51 | | 5,433,605 08 |
| Contracts completed, improving Wachusett Watershed: — | | | | |
| Sterling filter-beds, | | - | | 11,893 75 |
| Contracts completed, Wachusett Aqueduct, | | - | | 1,447,208 55 |
| Contracts completed, Sudbury Reservoir, | | - | | 1,545,028 33 |
| Contracts completed, protection Sudbury supply: — | | | | |
| City of Marlborough, main sewer, | | - | | 9,000 00 |
| Contracts completed, improving Lake Cochituate, | | - | | 60,657 45 |
| Contracts completed, protection Cochituate supply: — | | | | |
| Town of Framingham, low-level sewer, | | - | | 9,000 00 |
| Contracts completed, Rosemary siphon, | | - | | 5,916 96 |
| Contracts completed, pipe line, Dam No. 3 to Dam No. 1, | | - | | 17,240 22 |
| Contracts completed, Clinton sewerage system, | | - | | 66,878 22 |
| Contracts, Weston Aqueduct: — | | | | |
| Contracts completed and final payments made prior to January 1, 1909, | - | | $1,781,564 31 | |
| Shanahan, Casparis & Co., Sect. 2, | - | | 201,827 74 | |
| Sundry bills paid under this contract, | $323 95 | | 3,235 75 | |
| Shanahan, Casparis & Co., Sect. 3, | - | | 126,420 70 | |
| Sundry bills paid under this contract, | 330 00 | | 4,544 78 | |
| Shanahan, Casparis & Co., Sect. 6, | - | | 108,933 26 | |
| Sundry bills paid under this contract, | 566 80 | | 7,579 85 | |
| Shanahan, Casparis & Co., Sect. 12, | - | | 138,151 78 | |
| Sundry bills paid under this contract, | 406 60 | | 3,746 37 | |
| | | 1,627 35 | | 2,376,004 54 |
| *Amounts carried forward,* | | $22,875 62 | | $13,468,930 13 |

| GENERAL CHARACTER OF EXPENDITURES. | For the Year ending December 31, 1909. | | From Beginning of Work to December 31, 1909. | |
|---|---|---|---|---|
| *Amounts brought forward,* | | $22,875 62 | | $13,468,930 13 |
| *Construction* — Con. | | | | |
| Contracts, Distribution System: — | | | | |
| Contracts completed and final payments made prior to January 1, 1909, | - | | $4,429,206 12 | |
| Allis-Chalmers Co., pumping engine, | $3,480 37 | | 8,375 37 | |
| Coffin Valve Co., water valves, | 5,827 80 | | 7,198 00 | |
| Warren Foundry and Machine Co., cast-iron pipes and special castings, | 58,693 59 | | 101,990 55 | |
| Bruno & Petitti, laying water pipes on Sect. 31 (new 48-inch main), | 29,669 85 | | 38,909 55 | |
| Camoia & Williams, laying water pipes on Sect. 32, | 3,473 99 | | 3,473 99 | |
| Angelo De Marco & Co., laying water pipes on Sect. 34, | 1,822 56 | | 1,822 56 | |
| Coffin Valve Co., water valves, | 9,750 00 | | 9,750 00 | |
| The Builders Iron Foundry Co., 60-inch Venturi meter tube, | 2,350 00 | | 2,350 00 | |
| Standard Cast Iron Pipe and Foundry Co., cast-iron pipes and special castings, | 55,984 59 | | 55,984 59 | |
| Camoia & Williams, laying water pipes on Sect. 33, | 12,444 78 | | 12,444 78 | |
| Chas. J. Jacobs Co., laying water pipes on Sect. 8 of Weston Aqueduct supply mains, | 20,978 75 | | 20,978 75 | |
| Florence Iron Works, cast-iron pipes and special castings, | 38,462 84 | | 38,462 84 | |
| Standard Cast Iron Pipe and Foundry Co., cast-iron pipes and special castings, | 3,395 75 | | 3,395 75 | |
| U. S. Cast Iron Pipe and Foundry Co., cast-iron pipes and special castings, | 58,604 27 | | 58,604 27 | |
| | | 304,939 14 | $4,792,947 12 | |
| Deduct value of pipes, valves, etc., included in above list, transferred to maintenance account December 31, 1900, | - | | 3,139 77 | |
| | | | | 4,789,807 35 |
| Additional work: — | | | | |
| Labor, | $10,657 31 | | $768,401 65 | |
| Professional services, medical services, analyses, etc., | 75 00 | | 1,982 99 | |
| Traveling, | 2 90 | | 2,747 10 | |
| Rent, | 90 49 | | 3,702 22 | |
| Water rates, | - | | 1,454 77 | |
| Freight and express, | 449 67 | | 13,469 32 | |
| Jobbing and repairing, | 12 05 | | 9,698 18 | |
| Tools, machinery, appliances and hardware supplies, | 924 37 | | 78,338 25 | |
| Electrical supplies, | 16 82 | | 5,378 63 | |
| Castings, ironwork and metals, | 1,658 25 | | 83,706 04 | |
| Iron pipe and valves, | 602 90 | | 62,053 17 | |
| *Amounts carried forward,* | $14,489 76 | $327,814 76 | $1,030,932 32 | $18,258,737 48 |

| General Statement of Expenditures. | For the Year ending December 31, [illegible]. | | From Beginning of Work to December 31, [illegible]. | |
|---|---|---|---|---|
| *Amounts brought forward* | [illegible] | [illegible] | [illegible] | [illegible] |
| *Construction — Con.* | | | | |
| *Heating supplies* | [illegible] | | [illegible] | |
| *Teams and carting* | [illegible] | | [illegible] | |
| *Fuel, oil and waste* | [illegible] | | [illegible] | |
| *Lumber and field buildings* | [illegible] | | [illegible] | |
| *Drain pipe* | - | | [illegible] | |
| *Brick, cement and stone* | [illegible] | | [illegible] | |
| *Sand, gravel and filling* | [illegible] | | [illegible] | |
| *Municipal and engineering work*, | [illegible] | | [illegible] | |
| *Police service* | - | | [illegible] | |
| *Sanitary inspection*, | - | | [illegible] | |
| *Judgments and settlements for damages*, | [illegible] | | [illegible] | |
| *Unclassified supplies*, | 454 11 | | [illegible] | |
| *Miscellaneous expenses*, | 115 97 | | [illegible] | |
| | | 23,543 74 | | 1,884,146 06 |
| *Legal and expert:* — | | | | |
| *Legal services*, | - | | 4,978 52 | |
| *Expert services*, | - | | 1,582 96 | |
| *Court expenses*, | - | | 1,317 20 | |
| *Miscellaneous expenses*, | - | | 155 80 | |
| | | - | | 8,034 48 |
| *Real Estate.* | | | | |
| *Legal and expert:* — | | | | |
| *Legal services*, | - | | $4,736 31 | |
| *Conveyancers and assistants*, | $340 00 | | 110,382 97 | |
| *Experts*, | - | | 17,871 58 | |
| *Appraisers*, | - | | 22,332 75 | |
| *Court expenses*, | - | | 11,139 43 | |
| *Criminal expenses*, | - | | 43 25 | |
| *Conveyancing supplies*, | 3 00 | | 3,184 53 | |
| *Conveyancing expenses*, | - | | 5,937 54 | |
| *Miscellaneous expenses*, | - | | 4,326 15 | |
| *Settlements made by Board*, | 3,440 00 | | 3,391,312 84 | |
| *Judgments*, | - | | 170,445 63 | |
| *Taxes and tax equivalents*, | - | | 68,182 41 | |
| *Care and disposal*, | 25 63 | | 86,891 69 | |
| | | 3,808 63 | | 3,896 787 08 |
| *Damages to Real Estate not taken, to Business and on Account of Loss of Wages.* | | | | |
| *Legal and expert:* — | | | | |
| *Legal services*, | - | | $1,130 67 | |
| *Expert services*, | - | | 2,857 62 | |
| *Court expenses*, | - | | 15,394 34 | |
| *Miscellaneous expenses*, | - | | 125 00 | |
| *Settlements*, | $700 00 | | 415,513 65 | |
| *Judgments*, | 3,550 00 | | 116,733 42 | |
| | | 4,250 00 | | 551,754 70 |
| *Amounts carried forward*, | | $359,417 13 | | $24,409,459 80 |

| GENERAL CHARACTER OF EXPENDITURES. | For the Year ending December 31, 1909. | | From Beginning of Work to December 31, 1909. | |
|---|---|---|---|---|
| *Amounts brought forward,* | | $359,417 13 | | $24,409,459 80 |
| *Claims on Account of Diversion of Water.* | | | | |
| Legal and expert: — | | | | |
| Legal services, | - | | $3,774 98 | |
| Expert services, | - | | 19,339 69 | |
| Court expenses, | - | | 20,775 49 | |
| Miscellaneous expenses, | - | | 1,289 58 | |
| Settlements, | - | | 917,350 00 | |
| Judgments, | $250 00 | | 220,969 67 | |
| | | 250 00 | | 1,183,499 41 |
| *Purchase of Existing Water Works.* | | | | |
| Legal and expert: — | | | | |
| Legal services, | - | | $1,878 89 | |
| Expert services, | - | | 13,569 82 | |
| Court expenses, | - | | 29,728 38 | |
| Miscellaneous expenses, | - | | 1,470 94 | |
| Settlements and judgments, | - | | 15,227,100 01 | |
| | | - | | 15,273,748 04 |
| *Relocation Central Massachusetts Railroad.* | | | | |
| Settlements, | | - | | 177,597 39 |
| Total amount of construction expenditures, | | $359,667 13 | | $41,044,304 64 |

| GENERAL CHARACTER OF EXPENDITURES. | For the Year ending December 31, 1909. | |
|---|---|---|
| MAINTENANCE AND OPERATION OF WORKS. | | |
| Administration: — | | |
| Commissioners, | $3,500 00 | |
| Secretary and assistants, | 4,722 38 | |
| Rent, | 447 17 | |
| Repairs of building, | 16 95 | |
| Fuel, | 21 06 | |
| Lighting, | 69 92 | |
| Postage, | 114 50 | |
| Printing, stationery and office supplies, | 1,138 68 | |
| Telephones, | 40 42 | |
| Traveling expenses, | 86 91 | |
| Miscellaneous expenses, | 425 38 | |
| | | $10,583 37 |
| General supervision: — | | |
| Chief engineer and assistants, | $25,303 03 | |
| Rent, | 1,341 55 | |
| Repairs of building, | 309 87 | |
| Fuel, | 64 19 | |
| Lighting, | 215 12 | |
| *Amounts carried forward,* | $27,233 76 | $10,583 37 |

| General Character of Expenditures. | For the Year ending December 31, 1909. | |
|---|---|---|
| *Amounts brought forward,* | $27,233 76 | $10,583 37 |
| Maintenance and Operation of Works — *Con.* | | |
| General supervision — *Con.* | | |
| Postage, | $40 00 | |
| Printing, stationery and office supplies, | 428 69 | |
| Telephones, | 704 87 | |
| Traveling expenses, | 324 86 | |
| Miscellaneous expenses, | 1,953 19 | |
| | | 30,685 37 |
| Pumping service: — | | |
| Labor, | $65,328 50 | |
| Fuel, | 42,351 50 | |
| Oil, waste and packing, | 1,643 66 | |
| Repairs, | 5,896 74 | |
| Small supplies, | 2,124 00 | |
| Rent, West Roxbury pumping station, | 794 82 | |
| | | 118,139 22 |
| Reservoirs, aqueducts, pipe lines, buildings and grounds: — | | |
| Superintendents, | $6,466 35 | |
| Engineering assistants, | 8,584 19 | |
| Sanitary inspectors, | 4,024 00 | |
| Labor, pay roll, | 125,464 42 | |
| Labor, miscellaneous, | 2,912 05 | |
| Alterations and repairs of pumping stations, | 1,070 98 | |
| Alterations and repairs of other buildings and structures, | 1,618 14 | |
| Automobiles, | 4,549 94 | |
| Brick, | 364 41 | |
| Brooms, brushes and janitor's supplies, | 95 03 | |
| Castings, ironwork and metals, | 1,606 97 | |
| Cement and lime, | 606 23 | |
| Drafting and photo supplies, | 284 08 | |
| Fertilizer and planting material, | 966 07 | |
| Freight and express, | 633 73 | |
| Fuel, | 2,854 18 | |
| Gypsy moth supplies, | 791 88 | |
| Hardware, | 1,000 78 | |
| Hay and grain, | 3,422 06 | |
| Horses, | - | |
| Lighting, | 502 02 | |
| Lumber, | 1,640 61 | |
| Machinery, | 696 83 | |
| Paints and oils, | 765 47 | |
| Pipe and fittings, | 13,553 18 | |
| Postage, | 114 97 | |
| Printing, stationery and office supplies, | 1,142 39 | |
| Rubber and oiled goods, | 222 04 | |
| Stable expenses, | 1,027 88 | |
| Sand, gravel and stone, | 181 34 | |
| Traveling expenses, | 2,682 22 | |
| *Amounts carried forward,* | $189,844 44 | $159,407 96 |

| GENERAL CHARACTER OF EXPENDITURES. | For the Year ending December 31, 1909. | |
|---|---|---|
| *Amounts brought forward,* | $189,844 44 | $159,407 96 |
| MAINTENANCE AND OPERATION OF WORKS — *Con.* | | |
| Reservoirs, aqueducts, pipe lines, buildings and grounds — *Con.* | | |
| Telephones, | 1,437 61 | |
| Teaming, | 851 43 | |
| Tools and appliances, | 1,110 64 | |
| Vehicles, harnesses and fittings, | 523 37 | |
| Municipal and corporation work, | 2,695 66 | |
| Miscellaneous expenses, | 5,420 68 | |
| | | 201,883 83 |
| Payments in lieu of taxes, | | 35,874 62 |
| Total expenditures for maintenance and operation, | | $397,166 41 |

## (*b*) *Receipts.*

The total amount of receipts from the operations of the Board and from sales of property for the year beginning January 1, 1909, and ending December 31, 1909, is $108,761.48, and the total amount from the time of the organization of the Metropolitan Water Board, July 19, 1895, to December 31, 1909, is $652,593.82. The general character of these receipts is as follows: —

| GENERAL CHARACTER OF RECEIPTS. | For the Year ending December 31, 1909. | | From Beginning of Work to December 31, 1909. | |
|---|---|---|---|---|
| For distribution back to District: — | | | | |
| Fees for admission to District, | - | | $92,265 00 | |
| Water furnished to cities and towns outside of District, | - | | 90,454 77 | |
| Water furnished to water companies, | - | | 37,145 88 | |
| | | - | | $219,865 65 |
| To the credit of the loan fund: — | | | | |
| Real estate and buildings, | $3,047 50 | | $38,048 02 | |
| Tools, supplies and reimbursements, | 1,457 29 | | 129,023 64 | |
| District entrance fees (Swampscott), | 90,000 00 | | 90,000 00 | |
| | | $94,504 79 | | 257,071 66 |
| To the credit of the maintenance fund: — | | | | |
| Tools, supplies and reimbursements, | $5,745 58 | | $7,225 74 | |
| | | 5,745 58 | | 7,225 74 |
| To the credit of the sinking fund: — | | | | |
| Water furnished to cities and towns outside of District and to water companies, | $2,300 17 | | $16,851 21 | |
| Forfeiture for contracts awarded but not executed, | - | | 500 00 | |
| Rents, | 1,110 38 | | 92,439 37 | |
| Land products, | 4,975 02 | | 55,382 28 | |
| Unclassified receipts and interest, | 125 54 | | 3,257 91 | |
| | | 8,511 11 | | 168,430 77 |
| Total receipts, | | $108,761 48 | | $652,593 82 |

The foregoing receipts have been credited to the various objects or works, as follows: —

| SOURCES OF RECEIPTS. | For the Year ending December 31, 1909. | | From Beginning of Work to December 31, 1909. | |
|---|---|---|---|---|
| Admission into Metropolitan Water District (Quincy, Nahant, Arlington, Stoneham, Milton, Lexington and Swampscott), | $90,000 00 | | $182,265 00 | |
| Supplying water to cities and towns outside of Water District (Swampscott, Revere, Lexington, Wakefield, Cambridge, Framingham and U. S. Government), and to water companies (Framingham, Milton and Revere), | 2,300 17 | | 144,451 86 | |
| | | $92,300 17 | | $326,716 86 |
| Construction and acquisition of works: — | | | | |
| Administration, | $74 56 | | $243 95 | |
| Wachusett Dam, | - | | 6,759 48 | |
| Wachusett Reservoir, | 665 84 | | 135,674 87 | |
| Wachusett Aqueduct, | - | | 5,204 70 | |
| Weston Aqueduct, | - | | 5,137 63 | |
| Sudbury Reservoir, | 2,820 00 | | 10,615 42 | |
| Distribution system, | 998 95 | | 74,358 28 | |
| Diversion of water, Clinton sewerage system, | - | | 1,367 94 | |
| Purchase of existing water works, | 75 00 | | 18,119 08 | |
| | | 4,634 35 | | 257,481 35 |
| Maintenance and operation of works: — | | | | |
| Administration, | $15 73 | | $118 56 | |
| General supervision, | 490 79 | | 802 76 | |
| Wachusett Aqueduct, | 300 41 | | 4,680 07 | |
| Wachusett Reservoir, | 4,698 22 | | 27,986 57 | |
| Sudbury system, | 1,859 73 | | 15,463 38 | |
| Distribution system, | 3,961 12 | | 14,465 53 | |
| Clinton sewerage system, | 500 96 | | 4,878 74 | |
| | | 11,826 96 | | 68,395 61 |
| Total receipts, | | $108,761 48 | | $652,593 82 |

## (c) *Assets.*

The following is an abstract of the assets of the Water Works, a complete schedule of which is kept on file in the office of the Board: —

Office furniture, fixtures and supplies; engineering and scientific instruments and supplies; police supplies; horses, vehicles, field machinery, etc.; machinery, tools and other appliances and supplies; real estate connected with works not completed; completed works, including real estate and buildings connected therewith.

### (*d*) *Liabilities.*

The sums due on monthly pay rolls amount to $1,487.46, and there are bills for current expenses which have not yet been received.

*Amounts on Monthly Estimates, not due until Completion of Contracts or until Claims are settled.*

| NAME. | Work. | Amount. |
|---|---|---|
| McBride & Co., . . . . . . | Contract 283, Stillwater Improvement, Wachusett Reservoir. | $778 09[1] |
| Camoia & Williams, . . . . . | Contract 308, Northern High-service Pipe Lines, Distribution System. | 2,196 14 |
| Chas. J. Jacobs Company, . . . . | Contract 310, Weston Aqueduct Supply Mains, Distribution System. | 3,702 13 |
| Florence Iron Works, . . . . . . | Contract 305, cast-iron water pipes, Distribution System. | 6,787 56 |
| Standard Cast Iron Pipe and Foundry Company. | Contract 306, special castings, Distribution System. | 599 25 |
| U. S. Cast Iron Pipe and Foundry Company. | Contract 302, cast-iron water pipes, Distribution System. | 10,399 94 |

[1] Held pending settlement of claims on account of this contract.

A claim of the town of Boylston for land taken has been settled for the sum of $800 but the papers in settlement have not yet been executed.

It is impossible to state the amounts due on the claims of the following for land damages, for water rights taken and for damages to established business, as no sums have been agreed upon, and suits are now pending in court for the determination of most of them: —

Patrick Bradley, Henry F. Keyes, James E. Welch, Byron D. Allen, J. Frank Wood *et al.*, Asa Knight, Edward F. Merriam, Sanford C. Kendall, estate of William H. Vickery, James H. and Hannah S. Wood, Francis W. M. Goodale, Nellie M. Kirby, Boston & Albany Railroad Company, heirs of Willard Morse.

## VII. METROPOLITAN SEWERAGE WORKS.

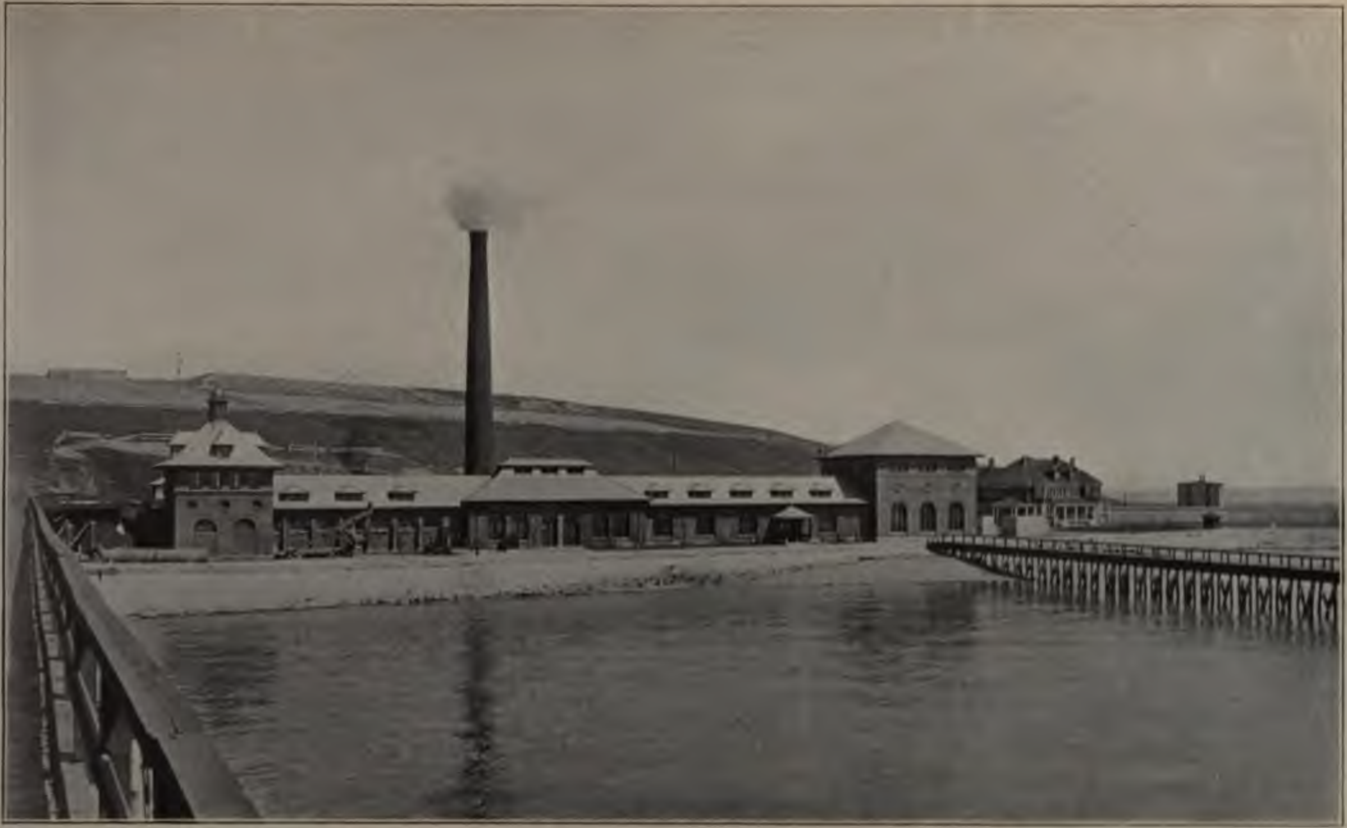
The North Metropolitan System provides for the area situated in the Mystic River valley and for the larger part of the Charles River valley which lies north of the Charles River. The district provides for and embraces the cities of Cambridge, Chelsea, Everett, Malden, Medford, Melrose, Somerville and Woburn, parts of the city of Boston, and the towns of Arlington, Belmont, Stoneham, Winchester and Winthrop, which were included in the original North Metropolitan District established under the Act of the year 1889. Under subsequent acts the district has been extended by the inclusion of the towns of Wakefield and Revere and a part of the town of Lexington, and now embraces 9 cities and 8 towns. The district has an area of 99.30 square miles. It has an estimated population as of December 31, 1909, based upon the census of 1905, of 515,397; and it is estimated that of this number, 445,637, or 86.5 per cent., contribute sewage to the North Metropolitan System.

The South Metropolitan System provides for the areas situated in that part of the Charles River valley lying south of the Charles River, a small portion of the valley north of the Charles River and also a portion of the Neponset River valley. The district includes what was originally established by the Act of the year 1889 as the Charles River Valley System, for the cities of Newton, Waltham and a part of the city of Boston, and the towns of Brookline and Watertown. It also includes the towns of Hyde Park and Milton and a part of the town of Dedham, which were embraced in the Neponset River Valley System established under the Act of 1895. The two systems were united under the name of the South Metropolitan System by the Act of the year 1899, providing for the High-level Sewer, which extended the system to the city of Quincy. There are now 4 cities and 5 towns included within the district, which has an area of 100.87 square miles. It has an estimated population, as of December 31, 1909, of 358,180, of which number it is estimated that 233,025, or 65.1 per cent., contribute sewage to the South Metropolitan System.

## (1) NORTH METROPOLITAN SEWERAGE SYSTEM — CONSTRUCTION.

### *(a) Deer Island Pumping Station Extension.*

The extension of the Deer Island pumping station which was authorized by the Legislature of the year 1908, and for which an appropriation of $195,000 was made, has been in progress during the year. The foundations for the building enlargement had already been built by day labor and a contract was made early in the season



SEWERAGE PUMPING STATION AND EXTENSION AT DEER ISLAND.

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for the building of the superstructure under which the work has been completed. The grounds about the extension have been graded and foundations for the additional engine and boilers have been built, this work having been performed by day labor.

Under a contract which had been made with the Allis-Chalmers Company of Milwaukee, Wisconsin, for furnishing a 100,000,000-gallon engine and centrifugal pump with boilers, various castings for the pump and engine have been delivered, the boilers have been put in place and the work has been nearly completed. It is expected that the engine will be in regular service by the middle of the year.

### (*b*) *East Boston Pumping Station Extension.*

Although the Board had been authorized by the Legislature of 1908 to enlarge the East Boston pumping station and provide for its equipment, for which an appropriation of $250,000 was made, after the occurrence of the Chelsea fire on April 12 of that year it had been deemed advisable to enter upon a careful investigation as to the future requirements of the North Metropolitan System before proceeding to rebuild permanently on the site at East Boston. It was subsequently determined to go on with the enlargement. The buildings had been temporarily repaired under a special appropriation made by the Legislature. In August of the past year, however, a contract was made for permanently repairing the injuries which had been done to the existing building, to make the extensions of the engine and boiler houses, and to build the new coal house, as had been originally proposed. The station, after the repairs and enlargement have been completed, will be, so far as possible, fire proof, and the extensions will be made in harmony with the old building. The new station will have a length of 268 feet and a width of 65 feet. It will provide for the storage of 1,500 tons of coal, and will contain a dynamo room and machine shop. Provision is made for the installation of a fourth centrifugal pumping engine of 100,000,000 gallons' capacity, with six new boilers. A portion of the masonry foundation for the extension has already been laid. A contract has been made with the Allis-Chalmers Company of Milwaukee for the new engine, which is to be similar in kind to that provided for the Deer Island station. Much of the work required in connection with the contracts has been carried on by day labor.

### (c) *Stable and Locker Buildings.*

The Board was authorized by a special Act of the year 1908 to use the money received from the sale of its land in East Boston for the purchase of other land and the erection of stable and locker buildings thereon. The Board has accordingly in the past month made an agreement for the purchase of a lot of land containing 8,715 square feet, with the flats appurtenant, situated on the easterly side of Chelsea Street and adjoining the Chelsea Creek. This lot is separated from the pumping station by the tracks of the Grand Junction Railroad. The Board will in the coming year enter upon the construction of the necessary buildings.

There will also be used for storage purposes in connection with the new premises a lot on the opposite side of the creek in Chelsea, which belongs to the Commonwealth and which has been gradually filled with material dumped from the pumping station.

## (2) SOUTH METROPOLITAN SEWERAGE SYSTEM — CONSTRUCTION.

The work of extending the High-level Sewer from the corner of Centre and Perkins streets in Jamaica Plain, through West Roxbury and Brookline and to Oak Square in Brighton, which has been in progress between two and three years, was completed in the earlier part of the past year. The entire length of the extension is 5.64 miles. Some of the work involved unusual difficulties, especially that portion of it which was in the vicinity of Jamaica Pond, where the means adopted through the process of compressed air were successful in preventing any injurious results. The work also included a good deal of rock excavation and the exercise of special care in order to prevent a disturbance of the residential district through which it was carried. The entire sewer has been satisfactorily completed, at an expense to the present date of $1,081,345.06. There are a few small bills to be paid, but there will be a considerable balance remaining out of the appropriation of $1,175,000. The larger balance is due to the success of the methods which were adopted, which involved more than the usual amount of risk and uncertainty.

### (3) Acquisition of Land.

There have been during the year but two takings of land or easements for the Metropolitan Sewerage Works. Both of the parcels were in the North Metropolitan District. One of these takings was made for the extension of the East Boston pumping station within Addison Street in East Boston. The other was of land in Cambridge and Arlington, made on account of the change in the sewer at Alewife Brook, necessitated by the improvements of the channel of the brook by the Metropolitan Park Commission.

*List of Takings for Metropolitan Sewerage Works for the Year 1909.*

| No. | Location and Description. | Former Owner. | Recorded. | Purpose of Taking. |
|---|---|---|---|---|
| 22 | East Boston, — a 6-foot strip within Addison Street, adjoining prior sewerage takings in 1892 and 1895. Area, fee in 426.2 square feet. Also rights of way in Addison Street and Boston & Albany Railroad location. | Trustees of the Equity Association. | 1909.<br>June 28. | Rebuilding East Boston pumping station. |
| 23 | Cambridge and Arlington, — on Alewife Brook and adjoining sewerage taking of January 7, 1893. Area, easements in 0.038 of an acre. | Boston & Maine Railroad. | Nov. 17. | Improvement of Alewife Brook valley. |

### (4) North Metropolitan System — Maintenance.

The main sewers operated in the North Metropolitan System have, the same as in the preceding year, a length of 58.57 miles. The connections from local sewers have been increased during the year by 1 public and 13 special connections, in all 13.06 miles in length. The local sewers connected with the North Metropolitan System are now 652.56 miles in length, and the number of these connections, public and special, has increased from 672 to 686.

The East Boston and Charlestown districts of Boston and the cities of Everett, Cambridge, Somerville and Chelsea still maintain both separate and combined sewers, but all of the other municipalities in the North Metropolitan System maintain separate sewers, admitting sewage, but not directly admitting any rain water.

There have been operated for the conveyance of the sewage of the North Metropolitan System four pumping stations, the Alewife Brook, Charlestown, East Boston and Deer Island pumping stations.

In the disposal of the sewage, all of the sewage is pumped once, the most of it twice, and a portion of it is pumped the third time, before it is finally disposed of in the harbor.

There have been pumped at the Alewife Brook pumping station 3,358,000 gallons of sewage per day, with an average lift of 12.74 feet, at a cost of $0.527 per million gallons per foot lifted; at the Charlestown station 32,100,000 gallons per day, 8.12 feet lift, at a cost of $0.177 per million gallons per foot lifted; at the East Boston station 58,600,000 gallons per day, 15.62 feet lift, at a cost of $0.089 per million gallons per foot lifted; and at the Deer Island station 60,600,000 gallons per day, 10.56 feet lift, at a cost of $0.103 per million gallons per foot lifted. Taking all of the stations the average cost per million gallons per foot lifted has been $0.116.

The average amount of sewage discharged daily into the harbor from the outfall off Deer Island was 60,600,000 gallons. The maximum daily rate of discharge for the year was reached on November 25, when it was for a short period about 139,500,000 gallons. The amount of sewage in the District averaged 135.98 gallons per day for each person, taking the estimated population of the district contributing sewage. The fact that a portion of the sewers in the District are combined sewers, directly admitting in part rain water, considerably increases the per capita amount.

Bituminous coal only is used at the pumping stations, and the total amount which was purchased for use at the various stations was 6,628.625 gross tons. The average price per gross ton varied from $3.69 to $4.44.

The amount of sewage pumped has slightly increased over the amount of the preceding year, but the amount was, with the increased population, below the normal on account of the favorable seasons.

The cost of maintenance of the North Metropolitan System during the past year was $141,387.71. This is slightly less than the cost of maintenance during the preceding year. There was charged to the maintenance account in addition to this sum, $4,675, which was paid out under the special appropriation for the renewal of the East Boston pumping station which was partially burned in the Chelsea fire.

### (*a*) *Shirley Gut Siphon.*

Largely on account of the dredging in the harbor in the vicinity of Shirley Gut, a considerable portion of the siphon through which the sewage is conveyed under the bed of the harbor from Point Shirley to Deer Island was uncovered. During the year there has been heavy riprap placed along the line of the siphon in order to defend it against further moving of the material and possible injury to the pipe.

### (*b*) *Siphon under Alewife Brook.*

The work of the Metropolitan Park Commission in moving the channel of Alewife Brook near the Alewife Brook pumping station has caused considerable changes to be made, and the channel has been carried to a greater distance from the station. It has also been found necessary, in order to conform to the deepening of the channel of the brook, to introduce a siphon into the branch of the metropolitan sewer leading across the brook to Arlington. Two siphon pipes have been carried in the bed of the channel in substitution of the main pipe for a length of 54 feet. The local Arlington sewer was also affected and various changes were required. All the changes now in progress are made by the Board, but it is understood that the expense is to be paid by the Metropolitan Park Commission.

### (*c*) *Changes caused by the Cambridge Subway.*

The plans for the subway being built by the Boston Elevated Railway Company through Main Street in the city of Cambridge interfere with the Metropolitan Sewer where it crosses the line of the subway at Portland Street, the bottom of the sewer being 6 feet above the bottom of the subway. It is therefore necessary to carry the sewage under the subway by means of two siphon pipes. The work involves many complications and is performed by the Railway Company. The introduction of siphons in the line of sewers will not only involve a large additional cost in the maintenance of the sewer, but results in a substantial reduction in its carrying capacity. The construction of the subway involves still further interference with the sewer, and the Board has notified the Company of a claim for damages by reason of the largely increased expense resulting to the Sewerage District.

### (4) *Winchester and Woburn Sewers.*

The condition of the branch of the North Metropolitan Sewer which receives the sewage of the city of Woburn and the town of Winchester has been such as to cause considerable trouble and complaint. The increasing population and at the same time the apparent reduction of the capacity of the sewer have rendered it at certain periods of heavy rain incapable of disposing of the sewage, and consequently there were short periods during a few days in the early spring when slight overflows occurred.

Careful investigations have been made during the past year of the capacity of this system, and it is believed that the troubles which have arisen have largely been caused by the improper discharge of tan bark, hair and other objectionable substances from the tanneries into the sewer. When permission was given to connect the tanneries with the Metropolitan Sewer it was on the distinct condition that all such matter should be excluded. These substances being admitted clog the sewer and consequently obstruct the flow of sewage, and in fact diminish the capacity of the sewer. The attention of the authorities of the two municipalities has been called to the condition, and demands have been made that proper works should be introduced, through settling tanks or otherwise, by which the objectionable matter shall be disposed of, and that only proper matter shall be allowed to enter the Metropolitan Sewer.

The officials of the town of Winchester have caused measures to be taken which will apparently remove the difficulty, but so far the authorities of the city of Woburn have not complied with the requirements of the Board. It is the opinion of the expert advisers of the Board that if only proper matter is allowed to enter the sewer, the present system will be sufficient for a long period to come properly to dispose of the sewage of this district.

### (5) SOUTH METROPOLITAN SYSTEM — MAINTENANCE.

There are operated in the South Metropolitan System main sewers of a length of 43.42 miles, an increase of 0.64 of a mile during the year. The connections from local sewers have been increased during the year by 18 public connections and 1 special connection, in all, 5 miles in length. The local sewers connected with the South

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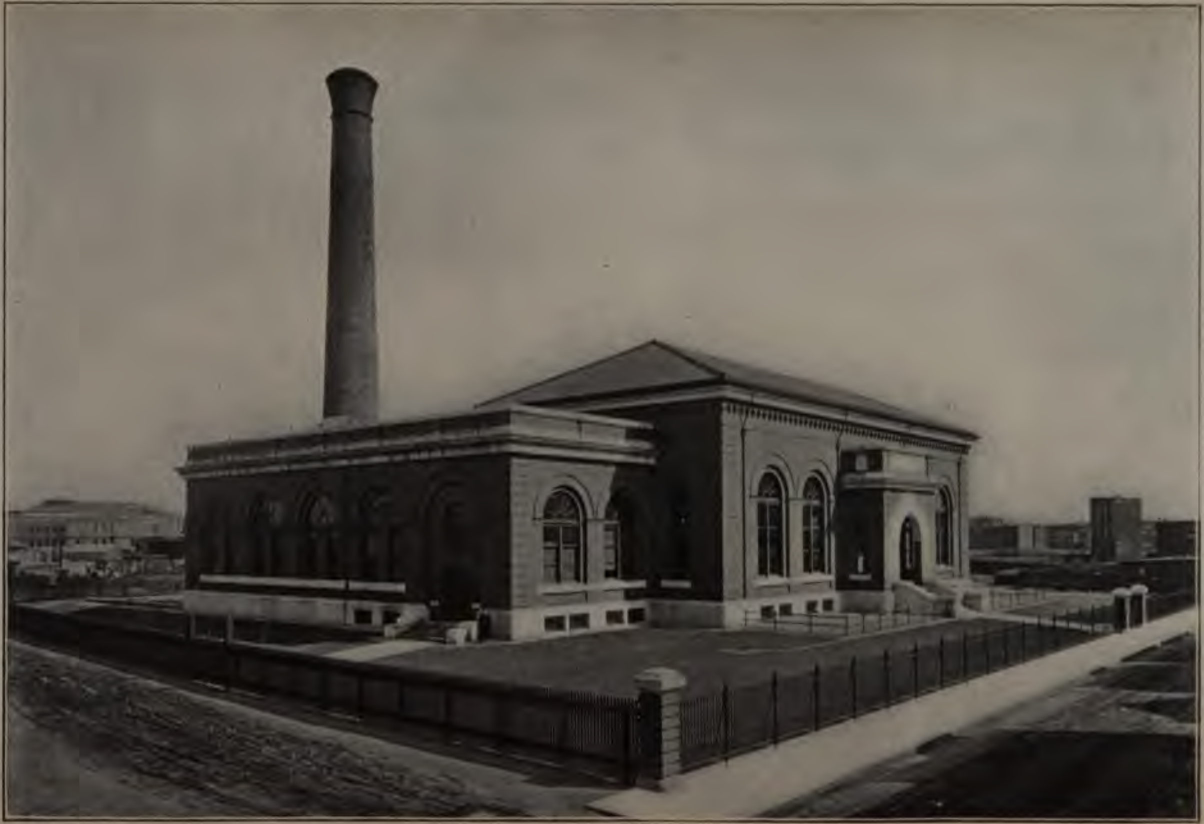

WARD STREET SEWERAGE PUMPING STATION.

Metropolitan System are now 524.01 miles in length, and the number of these connections has increased from 117 to 136.

The Back Bay, Roxbury, West Roxbury, Brighton and Dorchester districts of Boston and the towns of Brookline and Milton still maintain both separate and combined sewers, but all the other districts contributory to this system maintain separate sewers.

There are two pumping stations operated in the South Metropolitan System. The Ward Street pumping station elevates into the High-level Sewer the sewage from the original Charles River valley sewer and also that which is contributed from a portion of the city of Boston. The sewage from the city of Quincy is also pumped into the High-level Sewer from the Quincy pumping station. Although the sewage is carried by gravity to the outfall pipes in the harbor, a screen-house is maintained at Nut Island for the purpose of removing the more objectionable matter contained in the sewage before it is finally discharged from the outfall.

There has been pumped at the Ward Street station an average of 22,700,000 gallons of sewage per day, with an average lift of 40.57 feet, at a cost of $0.077 per million gallons per foot lifted; and at the Quincy station 4,163,000 gallons, 21.17 feet lift, at an average cost of $0.208 per million gallons per foot lifted. From all the stations the average cost per million gallons per foot lifted has been $0.089.

An average of 40,400,000 gallons of sewage has been discharged daily from the outfalls into the outer harbor. The maximum rate of discharge per day, which was 135,500,000 gallons, was reached on February 20.

The average discharge of sewage in the South Metropolitan System was at the rate of 173.37 gallons per day per person of the estimated number contributing sewage in the District. This larger per capita discharge is in part because, on account of its greater size, more storm water is admitted into the High-level Sewer at periods of heavy rainfall.

The total amount of coal, all of which is bituminous, which was purchased for use at the stations, was 2,373.303 gross tons. The contract price per gross ton varied from $3.97 to $4.33.

There has been considerable increase in the number of gallons of sewage discharged into the harbor, largely owing to the additional population contributing sewage to the system. Some decrease in the cost of sewage disposal is due largely to a decrease in the cost of coal.

All the sewage of the South Metropolitan System is now disposed of through the outfall pipes off Nut Island, with the exception of that from a small area in the districts of Dorchester and Milton, which is so low that its sewage cannot be carried into the High-level Sewer except by pumping. The sewage of this area consequently is disposed of by the city of Boston through its Main Drainage Works, and for this service a rental is paid to the city.

The expenditures for maintenance of the South Metropolitan System for the past year were $97,279.56, which is also a very slight decrease from the total amount expended during the preceding year.

### (*a*) *High-level Sewer Extension.*

The High-level Sewer extension was put into operation in the early part of the year and has since been in regular service. The extension of this sewer to the higher parts of the town of Brookline has caused many connections to be made for the 1,850 acres of territory in that town which have become contributory to the sewer.

### (*b*) *Outfalls of High-level Sewer.*

A careful examination has been made of the two 60-inch outfall pipes through which the sewage of the South Metropolitan System is emptied into the harbor. They were entered by a diver for a considerable distance, and the pipes were found clean and the outfalls were shown in every respect to be in a satisfactory condition, although they have now been in use for a period of five years.

## VIII. SEWERAGE WORKS — FINANCIAL STATEMENT.

The financial abstract of the receipts, expenditures, disbursements, assets and liabilities of the Metropolitan Water and Sewerage Board for the fiscal year of the Commonwealth ending with the thirtieth day of November, 1909, was, as stated in connection with the Water Works, presented to the General Court in January, in accordance with the requirements of chapter 235 of the Acts of the year 1906, and a copy of this financial abstract is in part printed as Appendix No. 7.

The following statement of its financial doings, in relation to the Metropolitan Sewerage Works, for the calendar year 1909, is herewith presented, in accordance with the provisions of the Act of 1906, as a part of the annual report of the Board.

The Metropolitan Sewerage Loans authorized for the construction of the Sewerage Works of the North Metropolitan System have amounted to $6,573,865.73, to which are added receipts from various sources amounting to $46,307.18. The amount of expenditures approved by the Board for payment for the year 1909 was $140,965.49, and the total amount of expenditures approved to January 1, 1910, was $6,312,130.61. The balance remaining on January 1, 1910, was $308,042.30.

The loans authorized for the construction of the various parts of the South Metropolitan System have amounted to $8,867,046.27. The receipts applicable to the loan fund have been $11,406.82. The amount of expenditures approved for payment in the year 1909 was $43,428.60. The total amount of expenditures approved for payment from the beginning of the works has been $8,785,297.80. The balance remaining for the South Metropolitan System on January 1, 1910, was $93,155.29.

The bonds issued on account of the loans have been for varying periods, not exceeding forty years, and bear interest at the rate of 3 per cent. and 3½ per cent. The premiums received on account of the sale of bonds for the North Metropolitan System have amounted to $179,106.65, and those received on account of the South Metropolitan System have amounted to $410,132.03.

The increase in the debt during the calendar year, as represented by the Metropolitan Sewerage Loans, was $300,000. The increase of the sinking fund for the payment of the debt at maturity was, during the same period, $180,742.30. There has consequently been an increase in the net debt during the calendar year amounting to $119,257.70.

The amount expended for maintenance of the North Metropolitan System in the year 1909 was $146,062.71, and for the South Metropolitan System $97,279.56, a total for both systems of $243,342.27.

The assessments made to meet interest, sinking fund requirements and maintenance and operation of the North Metropolitan System amounted in the year 1909 to $401,660.84, and the assessments for the South Metropolitan System amounted to $457,371.71.

The following is a detailed financial statement regarding the Metropolitan Sewerage Works: —

### (1) METROPOLITAN SEWERAGE LOANS, RECEIPTS AND PAYMENTS.

The loans authorized for the construction of the Metropolitan Sewerage Works, the receipts which are added to the proceeds of these loans, and the expenditures for construction, have been as follows: —

#### (a) *North Metropolitan System.*

| | | |
|---|---|---|
| *Loans authorized under the various acts, including those for the Revere, Belmont and Malden extensions and North System enlargement and extension,* . . . . . . | | $6,573,865 73 |
| *Receipts from sales of real estate and from miscellaneous sources, which are placed to the credit of the North Metropolitan System:* — | | |
| *For the year ending December 31, 1909,* . | $10,423 97 | |
| *For the period prior to January 1, 1909,* . | 35,883 21 | |
| | | 46,307 18 |
| | | $6,620,172 91 |
| *Amount approved for payment by the Board*[1] *out of the Metropolitan Sewerage Loan Fund, North System:* — | | |
| *For the year ending December 31, 1909,* . | $140,965 49 | |
| *For the period prior to January 1, 1909,* . | 6,171,165 12 | |
| | | 6,312,130 61 |
| Balance, North Metropolitan System, January 1, 1910, . . . . . . . . . . . | | $308,042 30 |

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[1] The word "Board" refers to the Metropolitan Sewerage Commission and the Metropolitan Water and Sewerage Board.

### (b) *South Metropolitan System.*

| | | | |
|---|---|---|---|
| Loans authorized under the various acts, applied to the construction of the Charles River valley sewer, Neponset valley sewer, High-level sewer and extension, . . . . | | | $8,867,046 27 |
| Receipts for pumping, sales of real estate and from miscellaneous sources, which are placed to the credit of the South Metropolitan System: — | | | |
| For the year ending December 31, 1909, . . . . | | | - |
| For the period prior to January 1, 1909, . . . . | | | 11,406 82 |
| | | | $8,878,453 09 |
| Amount approved by the Board[1] for payment out of the Metropolitan Sewerage Loan Fund, South System: — | | | |
| On account of the Charles River valley sewer, . . . . . . . . | | $800,046 27 | |
| On account of the Neponset valley sewer, . | | 911,531 46 | |
| On account of the High-level sewer and extension: — | | | |
| For the year ending December 31, 1909, . | $43,428 60 | | |
| For the period prior to January 1, 1909, . | 7,030,291 47 | | |
| | | 7,073,720 07 | |
| | | | 8,785,297 80 |
| Balance, South Metropolitan System, January 1, 1910, . | | | $93,155 29 |

### (2) ISSUES OF METROPOLITAN SEWERAGE LOAN BONDS.

The Treasurer of the Commonwealth, under the authority of the successive statutes, has from time to time issued bonds designated "Metropolitan Sewerage Loan," as follows: —

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[1] The word "Board" refers to the Metropolitan Sewerage Commission and the Metropolitan Water and Sewerage Board.

### METROPOLITAN SEWER LOANS, NORTH SYSTEM.

*Bonds issued.*

| DATE OF SALE. | Amount of Bonds sold. | Rate of Interest (Per Cent.). | Price received. | Date due. | Premium. |
|---|---|---|---|---|---|
| Apr. 2, 1890, . . . . . . | $500,000 | 3 | 102.40 | Jan. 1, 1930 | $12,000 00 |
| Apr. 2, 1890, . . . . . . | 500,000 | 3 | 103.02 | Jan. 1, 1930 | 15,100 00 |
| Apr. 2, 1890, . . . . . . | 500,000 | 3 | 103.62 | Jan. 1, 1930 | 18,100 00 |
| Apr. 2, 1890, . . . . . . | 500,000 | 3 | 102.327 | Jan. 1, 1930 | 11,635 00 |
| Apr., 1890, . . . . . . | 200,000 | 3 | 103. | Jan. 1, 1930 | 6,000 00 |
| Feb., 1891, . . . . . . | 50,000 | 3 | 104. | Jan. 1, 1930 | 35,130 30[1] |
| Mar., 1891, . . . . . . | 300,000 | 3 | 104. | Jan. 1, 1930 | |
| Mar., 1891, . . . . . . | 18,000 | 3 | 104. | Jan. 1, 1930 | |
| Jan., 1892, . . . . . . | 35,000 | 3 | 100. | Jan. 1, 1930 | - |
| Feb., 1892, . . . . . . | 29,000 | 3 | 100. | Jan. 1, 1930 | - |
| Mar., 1892, . . . . . . | 50,000 | 3 | 101. | Jan. 1, 1930 | 500 00 |
| June, 1892, . . . . . . | 436,000 | 3 | 101.50 | Jan. 1, 1930 | 11,060 00[1] |
| July, 1892, . . . . . . | 150,000 | 3 | 101.50 | Jan. 1, 1930 | |
| Aug., 1892, . . . . . . | 150,000 | 3 | 101.50 | Jan. 1, 1930 | |
| Nov., 1892, . . . . . . | 3,000 | 3 | 100.50 | Jan. 1, 1930 | 15 00 |
| Nov., 1892, . . . . . . | 200,000 | 3 | 100. | Jan. 1, 1930 | - |
| Jan., 1893, . . . . . . | 35,000 | 3 | 100.50 | Jan. 1, 1930 | 175 00 |
| Jan., 1893, . . . . . . | 25,000 | 3 | 100.50 | Jan. 1, 1930 | 125 00 |
| Feb., 1893, . . . . . . | 20,000 | 3 | 101. | Jan. 1, 1930 | 200 00 |
| Feb., 1893, . . . . . . | 5,000 | 3 | 100.50 | Jan. 1, 1930 | 25 00 |
| Feb., 1893, . . . . . . | 400,000 | 3 | 100.25 | Jan. 1, 1930 | 1,000 00 |
| Mar., 1893, . . . . . . | 94,000 | 3 | 100.25 | Jan. 1, 1930 | 235 00 |
| May 1, 1894, . . . . . . | 464,000 | 3 | 100. | Jan. 1, 1930 | - |
| Oct., 1894, . . . . . . | 4,000 | 3 | 100. | Jan. 1, 1930 | - |
| Oct., 1894, . . . . . . | 1,000 | 3 | 100. | Jan. 1, 1930 | - |
| Nov., 1894, . . . . . . | 15,000 | 3 | 100. | Jan. 1, 1930 | - |
| Nov., 1894, . . . . . . | 10,000 | 3 | 100. | Jan. 1, 1930 | - |
| Dec., 1894, . . . . . . | 6,000 | 3 | 100. | Jan. 1, 1930 | - |
| Apr., 1895, . . . . . . | 300,000 | 3 | 100. | Jan. 1, 1930 | - |
| Dec., 1896, . . . . . . | 30,000 | 3 | 100. | Jan. 1, 1930 | - |
| June, 1897, . . . . . . | 70,000 | 3½ | 106.243 | Jan. 1, 1930 | 5,084 80[1] |
| June, 1897, . . . . . . | 10,000 | 3½ | 106.243 | Jan. 1, 1930 | |
| Apr., 1898, . . . . . . | 5,000 | 3 | 100. | Jan. 1, 1930 | 22,843 75[1] |
| June, 1898, . . . . . . | 155,000 | 3½ | 100. | Jan. 1, 1930 | |
| June, 1898, . . . . . . | 60,000 | 3½ | 100. | Jan. 1, 1930 | |
| Apr., 1900, . . . . . . | 265,000 | 3 | 103.948 | Jan. 1, 1930 | 10,462 20 |
| May, 1903, . . . . . . | 200,000 | 3½ | 104.9797 | Jan. 1, 1930 | 9,959 40 |
| May, 1903, . . . . . . | 50,000 | 3½ | 106.2424 | Jan. 1, 1943 | 3,121 20 |
| July, 1903, . . . . . . | 250,000 | 3½ | 104.419 | July 1, 1943 | 11,047 50 |
| June, 1906, . . . . . . | 55,000 | 3½ | 103.09 | July 1, 1943 | 1,699 50 |
| Mar. 1909, . . . . . . | 300,000 | 3½ | 101.196 | Jan. 1, 1949 | 3,588 00 |
| | $6,450,000 | | | | $179,106 65 |

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[1] Readjustment of Treasurer.

## METROPOLITAN SEWER LOANS, SOUTH SYSTEM.

*Bonds issued.*

| DATE OF SALE. | Amount of Bonds sold. | Rate of Interest (Per Cent.). | Price received. | Date due. | Premium. |
|---|---|---|---|---|---|
| Apr., 1890, | $100,000 | 3 | 103. | Jan. 1, 1930 | $3,000 00 |
| Apr., 1890, | 400,000 | 3 | 103. | Jan. 1, 1930 | 12,000 00 |
| May, 1890, | 300,000 | 3 | 104. | Jan. 1, 1930 | 12,000 00 |
| Aug., 1895, | 300,000 | 3 | 100.585 | Mar. 1, 1935 | 1,755 00 |
| Feb., 1896, | 50,000 | 3 | 100. | Mar. 1, 1935 | - |
| Dec., 1896, | 135,000 | 3 | 100. | Mar. 1, 1935 | - |
| Dec., 1896, | 15,000 | 3 | 100. | Mar. 1, 1935 | - |
| June, 1907, | 300,000 | 3½ | 106.98 | Mar. 1, 1935 | 20,940 00 |
| June, 1898, | 35,000 | 3½ | 100. | Mar. 1, 1935 | 4,088 00[1] |
| June, 1899, | 25,000 | 3 | 100.64 | Mar. 1, 1936 | 160 00 |
| June, 1899, | 1,000,000 | 3 | 100.64 | July 1, 1939 | 6,400 00 |
| Sept., 1900, | 10,000 | 3 | 100.79 | July 1, 1939 | 79 00 |
| Sept., 1900, | 912 | 3 | 100. | July 1, 1939 | - |
| Apr., 1901, | 40,000 | 3 | 100.915 | Mar. 1, 1936 | 366 00 |
| Sept., 1901, | 2,000,000 | 3½ | 106.71 | July 1, 1940 | 134,200 00 |
| Sept., 1902, | 14,000 | 3 | 100. | July 1, 1939 | - |
| Sept., 1902, | 500,000 | 3½ | 107.243 | July 1, 1940 | 36,215 00 |
| Sept., 1902, | 150,000 | 3½ | 107.2395 | July 1, 1940 | 10,859 25 |
| Dec., 1902, | 200,000 | 3½ | 107.79 | July 1, 1940 | 15,580 00 |
| Feb., 1903, | 100,000 | 3½ | 108.25 | July 1, 1940 | 8,230 56[1] |
| Apr., 1903, | 100,000 | 3½ | 106.75 | July 1, 1940 | 6,750 00 |
| Apr., 1903, | 175,000 | 3½ | 106.75 | July 1, 1940 | 11,812 50 |
| Apr., 1903, | 203,000 | 3½ | 106.75 | July 1, 1940 | 13,702 50 |
| Apr., 1903, | 25,000 | 3½ | 106.494 | July 1, 1940 | 1,623 50 |
| Apr., 1903, | 133,000 | 3½ | 105.9364 | July 1, 1940 | 7,895 42 |
| May, 1903, | 996,000 | 3½ | 106.2424 | Jan. 1, 1943 | 62,174 31 |
| May, 1903, | 4,000 | 3½ | 105.5453 | Mar. 1, 1935 | 221 81 |
| July, 1904, | 392,000 | 3½ | 104.929 | July 1, 1944 | 19,321 68 |
| June, 1906, | 154,000 | 3½ | 103.09 | Jan. 1, 1946 | 4,758 60 |
| June, 1906, | 21,000 | 3½ | 103.09[2] | Jan. 1, 1946 | 648 90 |
| Apr., 1907, | 300,000 | 3½ | 101.85 | Jan. 1, 1947 | 5,550 00 |
| Apr., 1908, | 700,000 | 3½ | 101.40 | Jan. 1, 1946 | 9,800 00 |
|  | $8,877,912 |  |  |  | $410,132 03 |

[1] Readjustment of Treasurer.

[2] Not issued or delivered until 1907.

## (3) METROPOLITAN SEWERAGE LOANS SINKING FUND.

Under the authority of chapter 122 of the Acts of the year 1899, the Treasurer and Receiver-General of the Commonwealth was required to consolidate the sinking funds of all the Metropolitan Sewerage Loans into one fund, to be known as the Metropolitan Sewerage Loans Sinking Fund.

The Board received, during the year, from rentals and from other sources, to be applied to the sinking fund, $169.38.

The sinking fund established has amounted at the end of each year to sums as follows: —

| | | | |
|---|---|---|---|
| December 31, 1899, . | $361,416 59 | December 31, 1905, . | $1,008,724 95 |
| December 31, 1900, . | 454,520 57 | December 31, 1906, . | 1,146,998 68 |
| December 31, 1901, . | 545,668 26 | December 31, 1907, . | 1,306,850 30 |
| December 31, 1902, . | 636,084 04 | December 31, 1908, . | 1,492,418 98 |
| December 31, 1903, . | 754,690 41 | December 31, 1909, . | 1,673,784 40 |
| December 31, 1904, . | 878,557 12 | | |

### (4) ANNUAL APPROPRIATIONS, RECEIPTS AND EXPENDITURES.

The annual appropriations for the maintenance of the Metropolitan Sewerage Works, the receipts of the Board which are added to the appropriations for maintenance, and the expenditures for maintenance for the year ending December 31, 1909, have been as follows: —

*North Metropolitan System.*

| | |
|---|---|
| Appropriation under chapter 104 of the Acts of 1909, . . | $146,900 00 |
| Balance of appropriation under chapter 582 of the Acts of 1908, . . . . . . . . . . . . . | 17,284 43[1] |
| Receipts from pumping and from other sources, . . . | 1,525 72 |
| | $165,710 15 |
| Amount approved by the Board for payment, . . . . | 146,062 71 |
| Balance January 1, 1910, . . . . . . . . | $19,647 44 |

*South Metropolitan System.*

| | |
|---|---|
| Appropriation under chapter 105 of the Acts of 1909, . . | $105,700 00 |
| Receipts from pumping and from other sources, . . . | 222 99 |
| | $105,922 99 |
| Amount approved by the Board for payment, . . . . | 97,279 56 |
| Balance January 1, 1910, . . . . . . . . | $8,643 43 |

---

[1] Of this balance, $12,609.43 is the remaining portion of the special appropriation of $40,000 made by chapter 582 of the Acts of 1908 for the restoration and equipment of the East Boston pumping station, on account of the Chelsea fire of April 12, 1908.

### (5) Annual Assessments.

Assessments for the year, amounting to $401,660.84, for the North Metropolitan System and to $457,371.71 for the South Metropolitan System, were required for the payment of interest and sinking fund requirements and the cost of maintenance and operation of works. The requirements for the North Metropolitan System were: for interest, $199,626.75; for the sinking fund, $57,121.81; and for maintenance, $144,912.28. For the South Metropolitan System the requirements were: for interest, $301,688.47; for the sinking fund, $57,091.01; and for maintenance, $98,592.23. The assessments for the North Metropolitan System were made upon the cities and towns in the District in accordance with chapter 369 of the Acts of the year 1906, and the assessments for the South Metropolitan System were made in accordance with ratios fixed by the Apportionment Commissioners appointed under the provisions of chapter 424 of the Acts of the year 1899. The respective assessments were as follows: —

*North Metropolitan Sewerage System.*

| | | | |
|---|---|---|---|
| Arlington, . . . | $9,169 53 | Revere, . . . | $11,252 34 |
| Belmont, . . . | 4,927 67 | Somerville, . . . | 56,184 31 |
| Boston, . . . | 69,561 33 | Stoneham, . . . | 4,766 06 |
| Cambridge, . . . | 92,920 56 | Wakefield, . . . | 8,125 52 |
| Chelsea, . . . | 26,387 53 | Winchester, . . . | 9,453 68 |
| Everett, . . . | 22,211 69 | Winthrop, . . . | 7,704 96 |
| Lexington, . . . | 3,378 52 | Woburn, . . . | 10,556 11 |
| Malden, . . . | 32,524 60 | | |
| Medford, . . . | 18,968 48 | Total, . . . | $401,660 84 |
| Melrose, . . . | 13,567 95 | | |

*South Metropolitan Sewerage System.*

| | | | |
|---|---|---|---|
| Boston, . . . | $189,305 15 | Quincy, . . . | $27,329 62 |
| Brookline, . . . | 85,583 96 | Waltham, . . . | 26,741 33 |
| Dedham, . . . | 11,208 87 | Watertown, . . . | 13,537 62 |
| Hyde Park, . . . | 14,539 42 | | |
| Milton, . . . | 21,888 20 | Total, . . . | $457,371 71 |
| Newton, . . . | 67,237 54 | | |

### (6) Expenditures for the Different Works.

The following is a summary of the expenditures made in the various operations for the different works: —

| CONSTRUCTION AND ACQUISITION OF WORKS. | For the Year ending December 31, 1909. | | From Beginning of Work to December 31, 1909. | |
|---|---|---|---|---|
| *North Metropolitan System.* | | | | |
| Original system, main line and branches, | | - | | $5,383,957 67 |
| Lexington branch, | | - | | 68,585 15 |
| Everett branch, | | - | | 54,877 12 |
| Wakefield branch, | | - | | 35,698 29 |
| Stoneham branch, | | - | | 11,574 10 |
| Revere extension, | | - | | 215,722 79 |
| Chelsea and Everett outlets, | | - | | 71,216 41 |
| Wakefield branch extension, | | - | | 190,081 97 |
| Belmont extension, | | - | | 57,363 06 |
| Malden extension: — | | | | |
| Administration, | - | | $3,610 46 | |
| Section 64, | $12,743 58 | | 58,792 27 | |
| Land takings, purchase and recording, | - | | 4,689 90 | |
| | | $12,743 58 | | 67,092 63 |
| Bulkhead, Chelsea Creek, | | - | | 3,231 00 |
| Stable and locker, East Boston, | | 10 00 | | 81 15 |
| North System, enlargement: — | | | | |
| Administration, | $5,136 86 | | $5,798 52 | |
| Deer Island pumping station, extensions and additions, | 97,937 39 | | 120,399 73 | |
| East Boston pumping station, extensions and additions, | 25,129 66 | | 26,443 02 | |
| Real estate: — | | | | |
| Legal, conveyancing and expert, | 8 00 | | 8 00 | |
| | | 128,211 91 | | 152,649 27 |
| Total for North Metropolitan System, | . . . | $140,965 49 | | $6,312,130 61 |
| *South Metropolitan System.* | | | | |
| Charles River valley sewer, main line, | - | | | $800,046 27 |
| Neponset River valley sewer: — | | | | |
| Main line, | - | | $866,595 66 | |
| Brookline branch, | - | | 44,935 80 | |
| | | | | 911,531 46 |
| High-level Sewer: — | | | | |
| Administration, | - | | $51,621 43 | |
| Apportionment commission, | - | | 2,000 00 | |
| Land takings, purchase and recording, | $2 64 | | 355,626 09 | |
| Quincy force main, | - | | 18,351 71 | |
| Quincy pumping station, | - | | 11,705 68 | |
| Section 43, Quincy, | - | | 411,749 22 | |
| Section 44, Quincy, | - | | 299,543 47 | |
| Section 45, Quincy, | - | | 76,139 36 | |
| Section 46, Quincy, | - | | 62,551 26 | |
| Section 47, Quincy, | - | | 109,786 58 | |
| Section 48, Quincy, | - | | 295,319 29 | |
| Sections 48 and 49, embankments, Quincy, | - | | 81,548 64 | |
| Section 49, Quincy, | - | | 169,020 18 | |
| Section 50, Quincy, | - | | 109,570 35 | |
| Section 51, Quincy, | - | | 87,203 68 | |
| Section 52, Quincy, | - | | 155,800 65 | |
| *Amounts carried forward,* | $2 64 | | $2,297,537 59 | $1,711,577 73 |

| CONSTRUCTION AND ACQUISITION OF WORKS. | For the Year ending December 31, 1909. | | From Beginning of Work to December 31, 1909. | |
|---|---|---|---|---|
| *Amounts brought forward,* | $2 64 | | $2,297,537 59 | $1,711,577 73 |
| *South Metropolitan System* — Con. | | | | |
| High-level Sewer — *Con.* | | | | |
| Section 53, Quincy, | - | | 98,042 42 | |
| Section 54, Quincy, | - | | 101,918 39 | |
| Section 55, Milton and Quincy, | - | | 305,316 90 | |
| Section 56, Milton, | - | | 105 736 94 | |
| Section 57, Milton, | - | | 68,783 24 | |
| Section 58, Milton, | - | | 94,069 72 | |
| Section 59, Milton, | - | | 104,444 62 | |
| Section 60, Milton, | - | | 60,796 13 | |
| Section 61, Milton, | - | | 129,598 76 | |
| Section 62, Milton, | - | | 129,612 28 | |
| Section 63, Milton, | - | | 127,142 45 | |
| Section 64, Neponset River crossing, | - | | 47,554 40 | |
| Section 65, Hyde Park, | - | | 41,333 37 | |
| Section 66, Hyde Park, | - | | 253,902 72 | |
| Section 67, Hyde Park, Stony Brook crossing, | - | | 32,298 33 | |
| Section 68, Hyde Park and Roxbury, | - | | 78,493 62 | |
| Section 69, West Roxbury, | - | | 102,143 68 | |
| Section 70, West Roxbury, | - | | 131,375 55 | |
| Section 71, West Roxbury, | - | | 91,888 22 | |
| Section 72, West Roxbury, | - | | 127,956 76 | |
| Section 73, West Roxbury, | - | | 494,290 42 | |
| Section 74, West Roxbury and Roxbury, | - | | 147,296 69 | |
| Section 75, Roxbury, | - | | 137,192 99 | |
| Section 76, Roxbury, cast-iron force main, | - | | 80,342 26 | |
| Section 77, Roxbury, Ward Street pumping station, | - | | 560,288 31 | |
| Section 78, Roxbury, connecting sewer, | - | | 35,994 69 | |
| Reversion of grade, Huntington Avenue, | - | | 6,503 56 | |
| | | $2 64 | | 5,992,375 01 |
| High-level Sewer extension: — | | | | |
| Charles River valley studies, | - | | $3,893 71 | |
| Administration, | $2,106 09 | | 14,935 85 | |
| Section 80, day work, West Roxbury and Brookline, | 12 00 | | 294,973 91 | |
| Section 81, Brookline, | 6,679 28 | | 129,364 35 | |
| Section 82, Brookline, | 224 71 | | 136,152 02 | |
| Section 82, day work, Park street crossing, | - | | 2,030 18 | |
| Section 83, Brookline, | - | | 93,818 87 | |
| Section 84, Brookline and Brighton, | - | | 47,592 89 | |
| Section 85, Brighton, | 20,848 46 | | 226,855 70 | |
| Section 85, day work, Brighton, | - | | 66,611 62 | |
| Section 86, Brighton, | 13,550 42 | | 57,189 88 | |
| Land takings, purchase and recording, | 5 00 | | 7,926 08 | |
| | | 43,425 96 | | 1,081,345 06 |
| Total for South Metropolitan System, | | $43,428 60 | | $8,785,297 80 |
| Total for construction for both systems, | | $184,394 09 | | $15,097,428 41 |

| Maintenance. | For the Year ending December 31, 1909. | From Beginning of Work to December 31, 1909. |
|---|---|---|
| North Metropolitan System | $146,06[illegible] 71 | $1,575,822 10 |
| South Metropolitan System | 97,279 56 | 1,309,285 30 |
| Total for maintenance of sewerage systems | $243,342 27 | $2,885,107 40 |

## (7) DETAILED FINANCIAL STATEMENT.

The Board herewith presents, in accordance with the Metropolitan Sewerage Acts, an abstract of the expenditures and disbursements, receipts, assets and liabilities for the year ending December 31, 1909.

### (a) *Expenditures and Disbursements.*

| General Character of Expenditures. | For the Year ending December 31, 1909. | |
|---|---|---|
| CONSTRUCTION OF WORKS AND ACQUISITION BY PURCHASE OR TAKING. | | |
| *North Metropolitan System.* | | |
| [illegible] | | |
| [illegible] | $2,323 33 | |
| [illegible] | 375 0[illegible] | |
| [illegible] | 1,646 67 | |
| [illegible] | 35 0[illegible] | |
| [illegible] stationery and office supplies. | 243 8[illegible] | |
| [illegible] lighting, heating, water and care of building. | 244 8[illegible] | |
| [illegible] | 121 2[illegible] | |
| [illegible] | 36 9[illegible] | |
| | | $5,1[illegible] |
| [illegible] | | |
| [illegible] | $1,[illegible] | |
| [illegible] | 1[illegible] 4[illegible] | |
| [illegible] | 4,[illegible] | |
| [illegible] | [illegible] | |
| [illegible] | 255 7[illegible] | |
| [illegible] | [illegible] | |
| [illegible] | [illegible] | |
| [illegible] | [illegible] | |
| [illegible] | 100 [illegible] | |
| [illegible] | [illegible] | |
| | | [illegible] |
| | | $35,2[illegible] |

| General Character of Expenditures. | | For the Year ending December 31, 1909. | |
|---|---|---|---|
| *Amount brought forward,* | | | $25,358 24 |
| *North Metropolitan System* — Con. | | | |
| Advertising, | | - | |
| Labor and teaming, | | $15,401 64 | |
| Tools, machinery and appliances, | | 2,559 83 | |
| Brick, cement, lumber and other field supplies and expenses, | | 7,438 64 | |
| | | | 25,400 11 |
| Contracts: — | | | |
| Woodbury & Leighton Co., contract 74, extension of engine, boiler, screen-house and coal-house at East Boston pumping station, | | $8,075 00 | |
| Allis Chalmers Co., contract 68, addition to pumping plant at Deer Island pumping station, | | 34,615 00 | |
| Walter A. Wentworth Co., contract 72, extension of engine and coal-houses at Deer Island pumping station, | | 34,755 56 | |
| Sundry bills paid under contract 64, | | 12,743 58 | |
| | | | 90,189 14 |
| Real estate: — | | | |
| Settlements, | | - | |
| Legal, conveyancing and expert, | | $18 00 | |
| | | | 18 00 |
| Total for North Metropolitan System, | | | $140,965 49 |
| *South Metropolitan System.* | | | |
| *High-level Sewer.* | | | |
| Administration: — | | | |
| Telephone, lighting, heating, water and care of building, | - | | |
| Miscellaneous expenses, | - | | |
| | | - | - |
| Engineers, inspectors, rodmen, laborers and others, | - | | |
| Tools and repairs of same, | - | | |
| Brick, cement, lumber and other field supplies, | - | | |
| Teaming and express, | - | | |
| Land takings, purchase and recording, | $2 64 | | |
| | | $2 64 | |
| | | | $2 64 |
| *High-level Sewer Extension.* | | | |
| Administration: — | | | |
| Commissioners, | $1,166 67 | | |
| Secretary, | 375 00 | | |
| Clerks and stenographers, | 225 00 | | |
| Traveling, | - | | |
| Stationery, printing and office supplies, | 155 16 | | |
| Telephone, lighting, heating, water and care of building, | 85 75 | | |
| Rent and taxes, main office, | 98 51 | | |
| Miscellaneous expenses, | - | | |
| | | $2,106 09 | |
| *Amounts carried forward,* | | $2,106 09 | $2 64 |

| General Character of Expenditures. | | For the Year ending December 31, 1909. | |
|---|---|---|---|
| *Amounts brought forward,* | | $2,106 09 | $2 64 |
| *South Metropolitan System* — Con. | | | |
| *High-level Sewer Extension* — Con. | | | |
| Engineering: — | | | |
| Chief engineer, | $1,250 00 | | |
| Engineering assistants, | 1,820 90 | | |
| Inspectors, | 911 11 | | |
| Traveling expenses, | - | | |
| Stationery, printing and office supplies, | 7 28 | | |
| Engineering and drafting instruments and tools, | - | | |
| Engineering and drafting supplies, | 37 52 | | |
| Telephone, lighting, heating, water and care of building, | 257 27 | | |
| Rent and taxes, | 295 54 | | |
| Miscellaneous expenses, | 31 35 | | |
| | | 4,610 97 | |
| Advertising, | - | | |
| Labor and teaming, | $1,457 04 | | |
| Tools, machinery and appliances, | 85 40 | | |
| Brick, cement, lumber and other field supplies and expenses, | 131 85 | | |
| | | 1,674 29 | |
| Contracts: — | | | |
| Bruno & Petitti, Section 81, in part, | $4,583 82 | | |
| Hugh Nawn Contracting Co., Section 81, in part, | 1,605 49 | | |
| Hugh Nawn Contracting Co., Section 85, in part, | 1,446 60 | | |
| D. F. O'Connell Co., Section 85, in part, | 17,166 02 | | |
| Glenn & Broderick, near Section 86, | 1,917 43 | | |
| Chas. J. Jacobs Co., Section 86 | 8,310 25 | | |
| | | 35,029 61 | |
| Real estate: — | | | |
| Settlements, | - | | |
| Legal, conveyancing and expert, | $5 00 | | |
| | | 5 00 | |
| | | | 43,425 96 |
| Total for South Metropolitan System, | | | $43,428 60 |
| Maintenance and Operation of Works. | | | |
| *North Metropolitan System.* | | | |
| Administration: — | | | |
| Commissioners, | | $2,333 33 | |
| Secretary and assistants, | | 2,264 00 | |
| Rent, | | 234 97 | |
| Heating, lighting and care of building, | | 133 29 | |
| Postage, | | 30 00 | |
| Printing, stationery and office supplies, | | 489 78 | |
| *Amount carried forward,* | | $5,485 37 | |

| General Character of Expenditures. | For the Year ending December 31, 1909. | |
|---|---|---|
| *Amount brought forward,* | $5,485 37 | |
| *North Metropolitan System* — Con. | | |
| Administration — *Con.* | | |
| Telephones, | 26 50 | |
| Traveling expenses, | 8 08 | |
| Miscellaneous expenses, | 24 38 | |
| | | $5,544 33 |
| General supervision: — | | |
| Chief engineer and assistants, | $5,676 98 | |
| Rent, | 704 93 | |
| Heating, lighting and care of building, | 398 93 | |
| Postage, | – | |
| Printing, stationery and office supplies, | 161 88 | |
| Telephones, | 185 76 | |
| Traveling expenses, | 258 20 | |
| Miscellaneous expenses, | 80 31 | |
| | | 7,466 99 |
| Deer Island pumping station: — | | |
| Labor, | $14,625 26 | |
| Fuel, | 11,254 78 | |
| Oil and waste, | 397 81 | |
| Water, | 1,351 67 | |
| Packing, | 167 93 | |
| Repairs and renewals, | 750 33 | |
| Telephones, | 217 85 | |
| General supplies, | 476 39 | |
| Miscellaneous supplies and expenses, | 49 07 | |
| East Boston pumping station: — | | |
| Labor, | 18,278 77 | |
| Fuel, | 10,874 66 | |
| Oil and waste, | 392 98 | |
| Water, | 1,703 33 | |
| Packing, | 47 88 | |
| Repairs and renewals, | 748 29 | |
| Telephones, | 133 55 | |
| General supplies, | 677 26 | |
| Miscellaneous supplies and expenses, | 266 09 | |
| Charlestown pumping station: — | | |
| Labor, | 14,303 92 | |
| Fuel, | 3,869 56 | |
| Oil and waste, | 273 80 | |
| Water, | 405 60 | |
| Packing, | 16 05 | |
| Repairs and renewals, | 1,110 55 | |
| Telephones, | 94 50 | |
| General supplies, | 412 87 | |
| Miscellaneous supplies and expenses, | 41 30 | |
| *Amounts carried forward,* | $82,942 05 | $13,011 32 |

| GENERAL CHARACTER OF EXPENDITURES. | For the Year ending December 31, 1909. | |
|---|---|---|
| *Amounts brought forward,* | $82,942 05 | $13,011 32 |
| *North Metropolitan System* — Con. | | |
| Alewife Brook pumping station: — | | |
| Labor, | 7,661 00 | |
| Fuel, | 1,291 86 | |
| Oil and waste, | 243 27 | |
| Water, | 271 44 | |
| Packing, | 37 32 | |
| Repairs and renewals, | 344 59 | |
| Telephones, | 63 20 | |
| General supplies, | 68 16 | |
| Miscellaneous supplies and expenses, | 1,159 62 | |
| | | 94,082 51 |
| Sewer lines, buildings and grounds: — | | |
| Engineering assistants, | $2,525 00 | |
| Labor, | 22,848 95 | |
| Automobiles, | 237 28 | |
| Brick, cement and lime, | 451 70 | |
| Castings, ironwork and metals, | 265 44 | |
| Freight, express and teaming, | 10 00 | |
| Fuel and lighting, | 94 83 | |
| Jobbing and repairing, | 136 05 | |
| Lumber, | 502 21 | |
| Machinery, tools and appliances, | 211 03 | |
| Paints and oils, | 335 70 | |
| Rubber and oiled goods, | 453 82 | |
| Sand, gravel and stone, | 40 95 | |
| Telephones, | 16 10 | |
| Traveling expenses, | 1,006 61 | |
| General supplies, | 613 36 | |
| Miscellaneous expenses, | 80 60 | |
| | | 29,829 63 |
| Horses, vehicles and stable account, | $4,464 25 | |
| Renewal East Boston pumping station, account Chelsea fire, April 12, 1908: — | | |
| Supplies and expenses, | 4,675 00 | |
| | | 9,139 25 |
| Total for North Metropolitan System, | . . . | $146,062 71 |
| *South Metropolitan System.* | | |
| Administration: — | | |
| Commissioners, | $1,166 67 | |
| Secretary and assistants, | 2,348 08 | |
| Rent, | 234 97 | |
| Heating, lighting and care of building, | 252 51 | |
| Postage, | 30 00 | |
| Printing, stationery and office supplies, | 449 63 | |
| Telephones, | 23 84 | |
| Traveling expenses, | 13 50 | |
| Miscellaneous expenses, | 7 67 | |
| *Amount carried forward,* | . . . | $4,526 87 |

| General Character of Expenditures. | For the Year ending December 31, 1909. | |
|---|---|---|
| *Amount brought forward,* | . . . | $4,526 87 |
| *South Metropolitan System* — Con. | | |
| General supervision: — | | |
| Chief engineer and assistants, | $4,170 00 | |
| Rent, | 704 93 | |
| Heating, lighting and care of building, | 774 52 | |
| Postage, | - | |
| Printing, stationery and office supplies, | 40 02 | |
| Telephones, | 211 53 | |
| Traveling expenses, | 35 00 | |
| Miscellaneous expenses, | 95 78 | |
| | | 6,031 78 |
| Ward Street pumping station: — | | |
| Labor, | $18,692 84 | |
| Fuel, | 8,468 54 | |
| Oil and waste, | 259 11 | |
| Water, | 1,375 20 | |
| Packing, | 188 12 | |
| Repairs and renewals, | 1,050 21 | |
| Telephones, | 113 25 | |
| General supplies, | 1,138 19 | |
| Miscellaneous supplies and expenses, | 752 67 | |
| Quincy pumping station: — | | |
| Labor, | 6,276 66 | |
| Fuel, | 1,342 98 | |
| Oil and waste, | 37 69 | |
| Water, | 205 55 | |
| Packing, | 30 95 | |
| Repairs and renewals, | 64 87 | |
| Telephones, | 47 73 | |
| General supplies, | 187 29 | |
| Miscellaneous supplies and expenses, | 279 93 | |
| Nut Island screen-house: — | | |
| Labor, | 7,036 84 | |
| Fuel, | 1,600 83 | |
| Oil and waste, | 74 12 | |
| Water, | 292 16 | |
| Packing, | 20 60 | |
| Repairs and renewals, | 7 70 | |
| Telephones, | 94 86 | |
| General supplies, | 386 02 | |
| Miscellaneous supplies and expenses, | 71 93 | |
| | | 50,096 84 |
| Sewer lines, buildings and grounds: — | | |
| Engineering assistants, | $4,200 00 | |
| Labor, | 19,569 46 | |
| Automobiles, | 166 22 | |
| Brick, cement and lime, | 95 00 | |
| Castings, ironwork and metals, | 64 37 | |
| *Amounts carried forward,* | $24,095 05 | $60,655 49 |

| General Character of Expenditures. | For the Year ending December 31, 1909. | |
|---|---|---|
| *Amounts brought forward,* | $24,095 05 | $60,655 49 |
| *South Metropolitan System* — Con. | | |
| Sewer lines, buildings and grounds — *Con.* | | |
| Freight, express and teaming, | 25 | |
| Fuel and lighting, | 118 35 | |
| Jobbing and repairing, | 34 40 | |
| Lumber, | 196 35 | |
| Machinery, tools and appliances, | 37 10 | |
| Paints and oils, | 166 43 | |
| Rubber and oiled goods, | 167 26 | |
| Sand, gravel and stone, | 36 00 | |
| Telephones, | 42 98 | |
| Traveling expenses, | 409 71 | |
| General supplies, | 241 78 | |
| Miscellaneous expenses, | 56 51 | |
| | | 25,602 17 |
| City of Boston, for pumping and interest, | | 7,700 00 |
| Horses, vehicles and stable account, | | 3,321 90 |
| Total for South Metropolitan System, | | $97,279 56 |

## (*b*) *Receipts.*

The receipts from the sales of property, from rents and from other sources, have been credited as follows: —

| Account. | For the Year ending December 31, 1909. | From Beginning of Work to December 31, 1909. |
|---|---|---|
| North Metropolitan System, — construction, | $10,423 97 | $46,307 18 |
| South Metropolitan System, — construction, | – | 11,406 82 |
| North Metropolitan System, — maintenance, | 1,525 72 | 11,559 64 |
| South Metropolitan System, — maintenance, | 222 99 | 1,476 70 |
| Metropolitan Sewerage Loans Sinking Fund, | 169 38 | 1,361 20 |
| Totals, | $12,342 06 | $72,111 54 |

## (*c*) *Assets.*

The following is an abstract of the assets of the Sewerage Works, a complete schedule of which is kept on file in the office of the Board: —

Office furniture, fixtures and supplies; engineering and scientific instruments and supplies; horses, vehicles, field machinery, etc.; machinery, tools and other appliances and supplies; real estate connected with works not completed; *completed* works, including real estate connected therewith.

### (*d*) *Liabilities.*

The sums due on monthly pay rolls amount to $748.62, and there are other current bills unpaid which have not yet been received.

*Amounts on Monthly Estimates, not due until Completion of Contracts or until Claims are settled.*

| NAME. | Work. | Amount. |
|---|---|---|
| High-level Sewer: — | | |
| National Contracting Co., | Sect. 73, contract abandoned, | $5,516 17[1] |
| E. W. Everson & Co., | Sect. 75, | 1,000 00 |
| High-level Sewer Extension: — | | |
| Timothy J. O'Connell, | Sect. 82, in part, | 60 00 |
| Geo. M. Bryne Co., | Sect. 85, in part, | 2,508 51 |
| Hugh Nawn Contracting Co., | Sect. 85, in part, | 500 00 |
| North Metropolitan Construction: — | | |
| Allis-Chalmers Co., | Addition to pumping plant at Deer Island pumping station, | 34,615 00 |
| Woodbury & Leighton Co., | Extension of engine, boiler, screen-house and coal house at East Boston pumping station, | 1,425 00 |
| | | $45,624 68 |

[1] Damages claimed by the Commonwealth on account of the abandonment of the contract exceed this amount.

Claims have been made by the following parties, but it is impossible to state the amounts due for land and other damages, as no sums have been agreed upon, and suits are now pending in the courts for the determination of most of them: —

Anna L. Dunican, Carrie S. Urquhart, N. Jefferson Urquhart, Edwin N. Urquhart, Richard Jones, James Doherty, Michael Niland, William H. Gibbons, Francis Normile, George A. Goddard, Boston & Albany Railroad Company.

## IX. CONSUMPTION OF WATER.

There has been a gratifying decrease in the consumption of water in the Metropolitan District during the past year. The daily average quantity of water supplied from the Metropolitan Water Works to the District was 119,386,000 gallons, as against a daily average consumption of 127,301,000 gallons in the preceding year, a decrease in the total daily average consumption of 7,915,000 gallons, and a decrease in the daily average consumption per inhabitant from 134.7 gallons to 123.7 gallons. These are the quantities as determined at the pumping stations and by the flow through the Weston Aqueduct, and include also the estimated yield at Spot Pond. The daily average quantity of water measured by the Venturi meters as delivered to the various municipalities is, owing to leakages from the reservoirs and pipe lines, and also to some extent to the use of water at the pumping stations, somewhat less than the amount above given, the daily average quantity consumed, according to the latter measurement, being 119,119,100 gallons, a daily average consumption per inhabitant of 123 gallons. This reduction in the consumption of water is due in part to the absence of long-continued periods of cold weather during the winter, and of hot, dry weather during the summer, and also, to some slight extent, due to the use of oil in place of water for street sprinkling; but the chief cause of the reduction is undoubtedly the increased use of water meters and greater vigilance on the part of municipal authorities.

The decrease in the total consumption occurred in every one of the municipalities except the city of Everett and the towns of Watertown and Lexington, and in every municipality except Watertown the daily average per capita consumption was decreased.

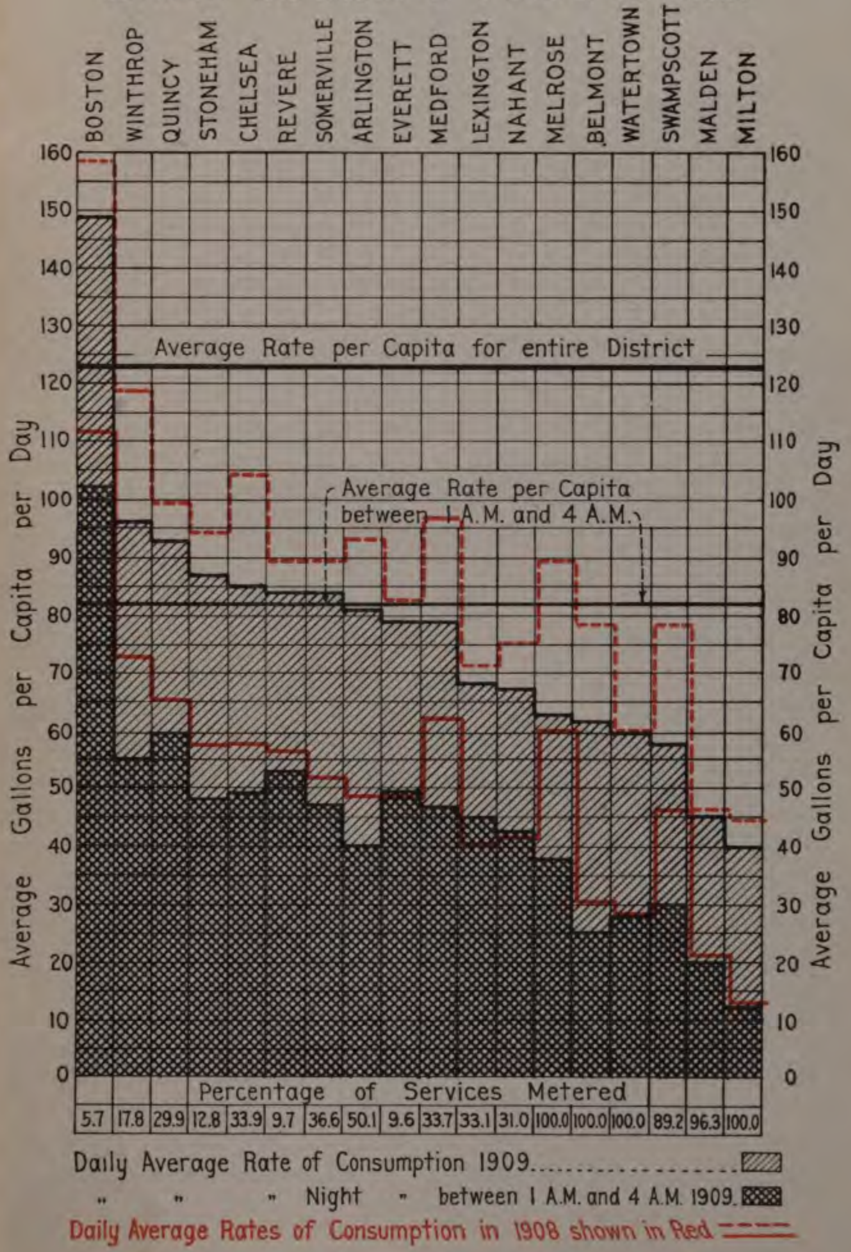
The great per capita reduction which has resulted in the municipalities of Melrose, Medford, Swampscott and Winthrop, where there has been the greatest activity in the installation of meters, shows conclusively the good effects which have resulted from their introduction. In fact, those cities and towns where meters have been more generally introduced have shown a notable comparative decrease in the amounts of their annual assessments, especially in comparison with other cities and towns where there has been much less metering of services.

In the city of Boston, where 6,584 services have been equipped with meters during the past year, the daily average consumption has decreased by 4,349,400 gallons, a reduction of the daily average consumption per capita from 158 gallons to 149 gallons.

The direct influence of the introduction of meters in the four municipalities above named is also shown in the annexed diagram, upon which the consumption of the year 1909, in comparison with that of the year 1908, is indicated.

That a very large proportion of the water supplied to the District continues to be wasted is evident when it appears that the average

## DIAGRAM SHOWING AVERAGE RATE OF CONSUMPTION OF WATER IN THE METROPOLITAN DISTRICT IN 1909 DURING THE ENTIRE DAY AND BETWEEN THE HOURS OF 1 AND 4 AT NIGHT



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rate of consumption in the District between the hours of 1 and 4 in the morning is 82 gallons per inhabitant, or just two-thirds of the average rate of consumption for the entire day, and that the rate of this night consumption in several of the cities and towns is more than one-half of that for the whole twenty-four hours.

The greatly increased consumption of water in continuous periods of very cold or of very hot and dry weather shows that large amounts of water are drawn unnecessarily or for purposes for which municipal water supplies were never intended, and which if generally practiced would render the supplies absolutely inadequate or of immoderate cost.

By the Act of the Legislature of last year the duty of supervising and promoting the enforcement of the law relative to the use and care of meters in the Metropolitan District was placed upon the Board. The returns called for by the Board from the various cities and towns show that there has been during the past year a general compliance with the requirements of the Act, that every city and town shall equip with meters all new water services installed and shall also equip in each year at least 5 per cent. of all services installed prior to January 1, 1908. The city of Quincy, however, has not complied with the provisions of the law, either as to the metering of the old services or in the equipment of new services.

It is made the duty of the Board to notify the Attorney-General of the violation or neglect to comply with the provisions of the Act of 1907 on the part of any city or town, and the municipality is made liable to a forfeiture or penalty for each day after December 31, 1908, during which such violation or neglect continues.

At the end of the year 28.35 per cent. of all the water services in the District had been metered, while at the beginning of the year the number metered was 21.5 per cent. Several of the cities and towns have proceeded far beyond the requirements of the Act. Excluding the city of Boston, 53.5 per cent. of all the services are metered, and in six of the cities and towns, Malden, Melrose, Watertown, Milton, Belmont and Swampscott, substantially all the services are equipped with meters.

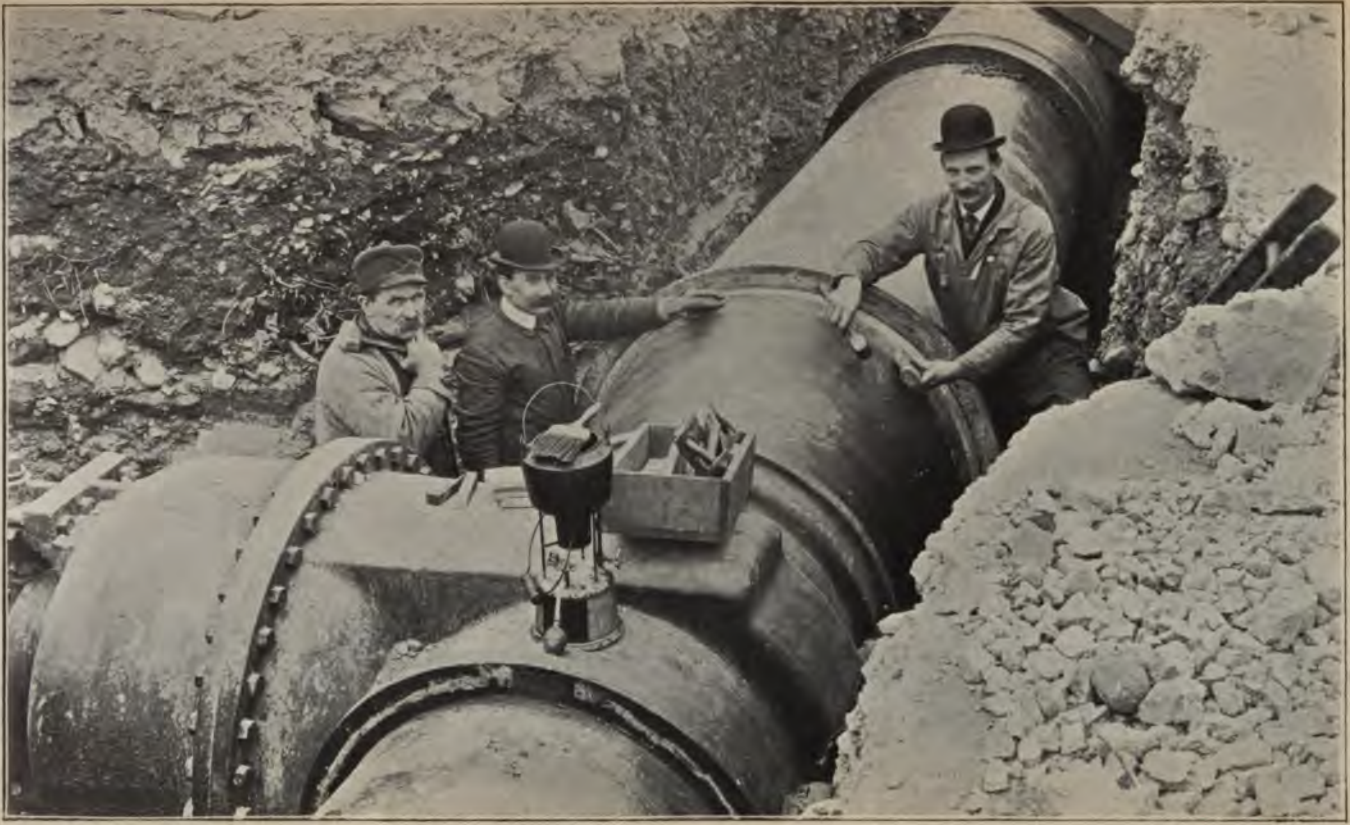
## [illegible] ELECTROLYSIS.

[illegible] during the past few [illegible] the pipes by electrolytic action. [illegible] currents maintained by the street [illegible] the main pipe lines. Rubber [illegible] three years been established [illegible] have been especially affected by [illegible] somewhat to diminish [illegible] introducing these joints has [illegible] however, that after [illegible] these insulating joints [illegible] rubber became carbonized [illegible] these rubber insulating [illegible] which are not only [illegible] and efficient. [illegible] the last year wooden staves [illegible] at intervals of [illegible] the new lines without great [illegible] very satisfactory. [illegible] indicate that the de[illegible] greater or [illegible] the Board has deemed it [illegible] maintenance [illegible] portion of the main [illegible] has been peculiarly [illegible] calling for [illegible]

## [illegible] FOR LEGISLATION.

[illegible] the Legislature. [illegible] year [illegible] recom[illegible] main for the high[illegible] an additional [illegible] the city of Boston. [illegible] —

[illegible] last year seems [illegible] A new [illegible]-inch main is



MAKING WOODEN INSULATING JOINTS ON 48-INCH MAIN IN BROOKLINE.

## X. ELECTROLYSIS.

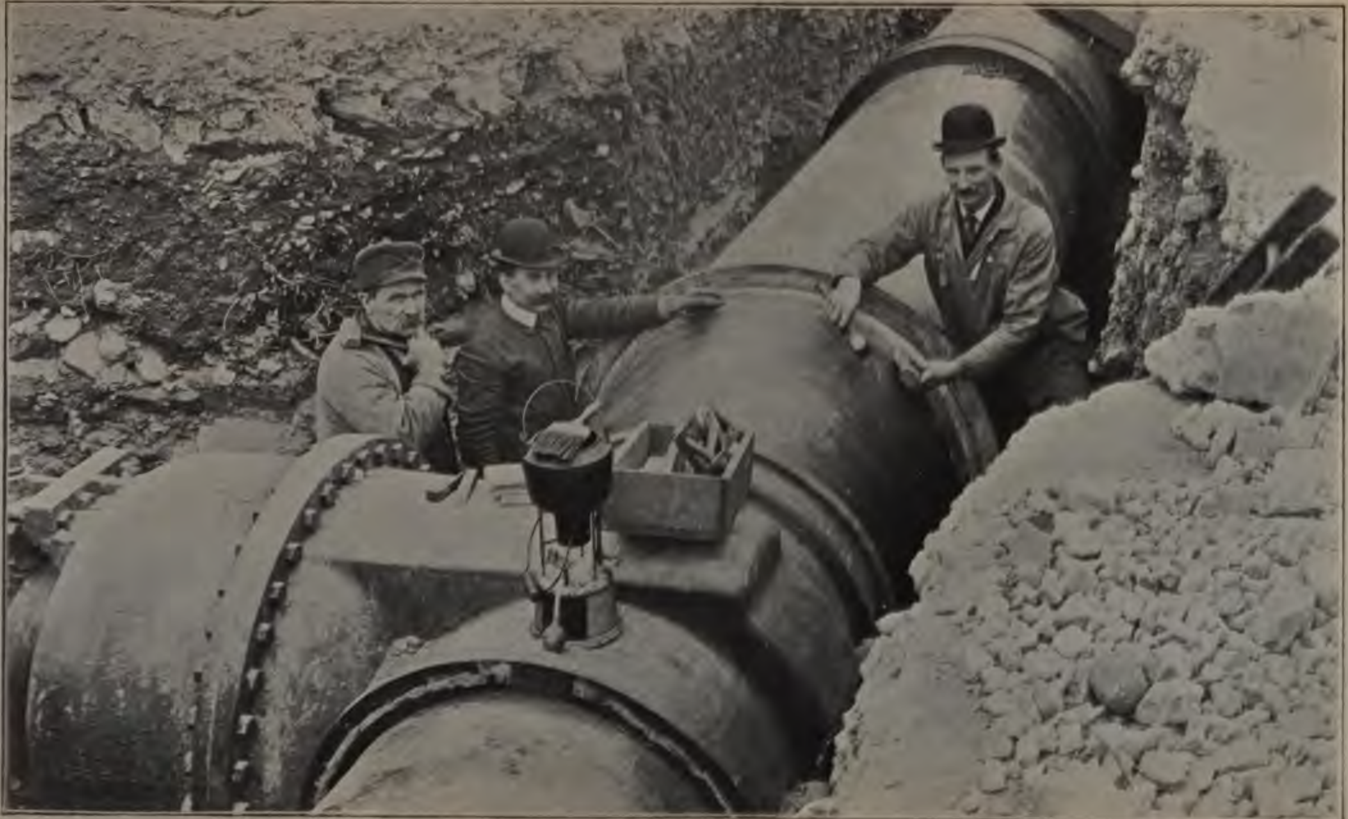
Various experiments have been carried on during the past few years for the prevention of injury to the pipes by electrolytic action, occasioned chiefly by the electric currents maintained by the street railways where their tracks approach the main pipe lines. Rubber insulating joints have in the past two or three years been established at certain points in the lines which have been especially affected by the electric currents, and these have appeared somewhat to diminish the injurious effects. The expense of introducing these joints has been paid by the railway company. It is found, however, that after a certain period of time the efficiency of these insulating joints usually decreased, for the reason that the rubber became carbonized and lost its insulating properties. Some of these rubber insulating joints have now been replaced with wooden joints, which are not only less expensive but seem to be decidedly more enduring and efficient. In the laying of new pipe lines during the past year wooden staves have been substituted for lead and jute in joints at intervals of about 500 feet. This can be done upon the new lines without great additional expense, and the result has so far proved very satisfactory.

The examinations which have been made indicate that the destructive effect of electrolytic action still goes on in greater or less degree according to the situation, and the Board has deemed it necessary to ask in its request for the appropriations for maintenance during the current year a sufficient sum to relay a portion of the main pipe on Boylston Street in Cambridge which has been peculiarly affected, and which it is feared has reached a condition calling for speedy attention.

## XI. RECOMMENDATIONS FOR LEGISLATION.

The Board in its abstract of the annual report to the Legislature, presented at the beginning of the session of the year 1910, recommended that it be authorized to construct a new main for the high-service districts of Lexington and Arlington and also an additional main for the supply of the East Boston district of the city of Boston. The recommendations made are as follows: —

"Some construction additional to that authorized last year seems to be called for during the coming year. A new 16-inch main is



Making WOODEN INSULATING JOINTS on 48-inch MAIN in Brookline.

If the small additional appropriation requested for the purpose, on account of maintenance, is made, the Board will at once proceed to carry out the proposed improvements of the Cochituate watershed by disposing of the surface drainage of the village of Cochituate in Wayland, for which plans and specifications are completed.

Various minor works for the protection of the water supply and the prevention of the pollution of the water are contemplated to be made upon the maintenance account.

If the authority asked for is obtained in accordance with its recommendations, the Board will forthwith proceed to lay a new main in Arlington for the reinforcement of the high service, and will also lay an additional main in Chelsea across Chelsea Creek for the better supply of the East Boston district.

It is also anticipated that arrangements will be completed by which the Board can proceed to the installation of a power plant at the Wachusett Dam in Clinton, for which an appropriation of $115,000 has already been made, with an additional sum of $7,000 for completing the power and gate house.

The work of enlargement and equipment with engines, pumps and boilers of the pumping stations at East Boston and at Deer Island is in progress and will be actively prosecuted during the year.

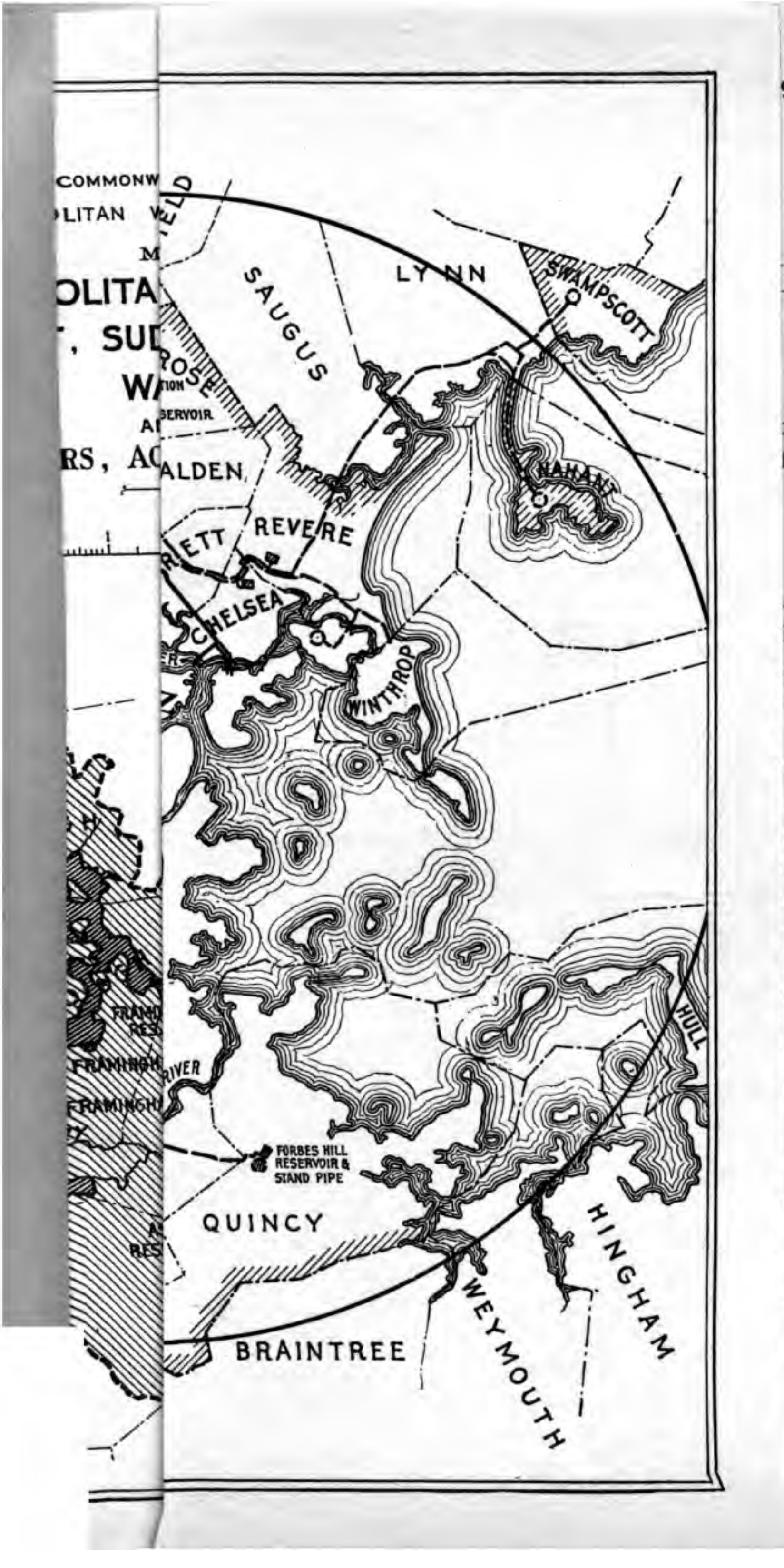
The Board has been called upon by the city of Quincy to proceed to the construction of a small pumping station and force main in order that the sewage of a low area in the eastern part of that city may be lifted into the Metropolitan High-level Sewer, as required by the original High-level Sewer Act, and this construction will probably be undertaken early in the current year.

The detailed reports of the Chief Engineer of the Water Works and of the Chief Engineer of the Sewerage Works, with various tables and statistics, are herewith presented.

Respectfully submitted,

HENRY H. SPRAGUE.
HENRY P. WALCOTT.
JAMES A. BAILEY, JR.

BOSTON, February 26, 1910.



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# REPORT OF CHIEF ENGINEER OF WATER WORKS.

*To the Metropolitan Water and Sewerage Board.*

GENTLEMEN: — The following is a report of the work under the charge of the Chief Engineer of the Metropolitan Water Works for the year ending December 31, 1909.

## GENERAL STATEMENT.

The Chief Engineer has under his charge not only the design and construction of new works, but also the maintenance and operation of the works already constructed. During the past year the amount of construction work in progress has been larger than for several previous years, the principal items of which are the completion of a 48-inch main for increasing the supply of water in the Boston low-service district, the laying of 24-inch and 16-inch mains to reinforce the supply in Chelsea, Revere, Winthrop, Swampscott and Nahant, the laying of a 12-inch main connecting with the Arlington standpipe, for the purpose of supplying water to the higher portions of the town of Belmont, and the laying of a portion of a line of 60-inch pipe, about 7 miles in length, for the purpose of bringing an additional supply of water from the Weston Aqueduct into the Metropolitan District. A contract has also been made for an additional pumping engine for the supply of the southern high-service district, which includes the city of Quincy, the towns of Milton, Watertown and Belmont and the higher portions of the city of Boston.

In connection with the maintenance of the works, improvements have been made at the Clinton sewerage filter-beds and at Lake Cochituate; changes have been made in the 30-inch high-service main in Malden, made necessary by the abolition of grade crossings, and in the 48-inch main in Cambridge, made necessary by the construction of the subway of the Boston Elevated Railway. An addition to the West Roxbury pumping station has been constructed in which has been installed a pumping engine and boiler.

## ORGANIZATION.

Since July 1, William E. Foss, who had previously had special charge, as division engineer, of electrolytic investigations and construction work in the Metropolitan District, has had more general charge of engineering work as assistant to the Chief Engineer.

The principal assistants employed under the direction of the Chief Engineer at the close of the year were as follows: —

| | |
|---|---|
| William E. Foss, | *Assistant to Chief Engineer.* |
| Elliot R. B. Allardice, | *Superintendent, Wachusett Department.* |
| Charles E. Haberstroh, | *Superintendent, Sudbury Department.* |
| Samuel E. Killam, | *Superintendent, Pipe Lines and Reservoirs, Distribution Department.* |
| Arthur E. O'Neil, | *Superintendent, Pumping Stations, Distribution Department.* |
| Alfred O. Doane, | *Division Engineer, specially in charge of engineering work at pumping stations.* |
| George E. Howe, | *Assistant Engineer.* |
| Clifford Foss, | *Assistant Engineer.* |
| Benjamin F. Hancox, | *Assistant in charge of Drafting Department.* |
| William E. Whittaker, | *Office Assistant.* |
| Arthur W. Walker, | *Biologist.* |
| William W. Locke, | *Sanitary Inspector.* |

At the beginning of the year the engineering force, including those engaged upon both the construction and maintenance of the works, numbered 40, and at the end of the year 48.

There has also been a maintenance force, exclusive of the engineers above mentioned, averaging 249, employed in the operation of the several pumping stations and in connection with the maintenance of the reservoirs, aqueducts and pipe lines, and in doing minor construction work.

The number of men employed in the maintenance force of the several departments has been as follows: —

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The laying of this main reduced the loss of head by friction between the pumping station at Chestnut Hill and the section of the city of Boston lying between Roxbury and Dover Street 20 to 25 feet. For the purpose of preventing injury to this main by electrolysis, insulating joints of wood were made at intervals of about 500 feet.

The total cost of the work was as follows: —

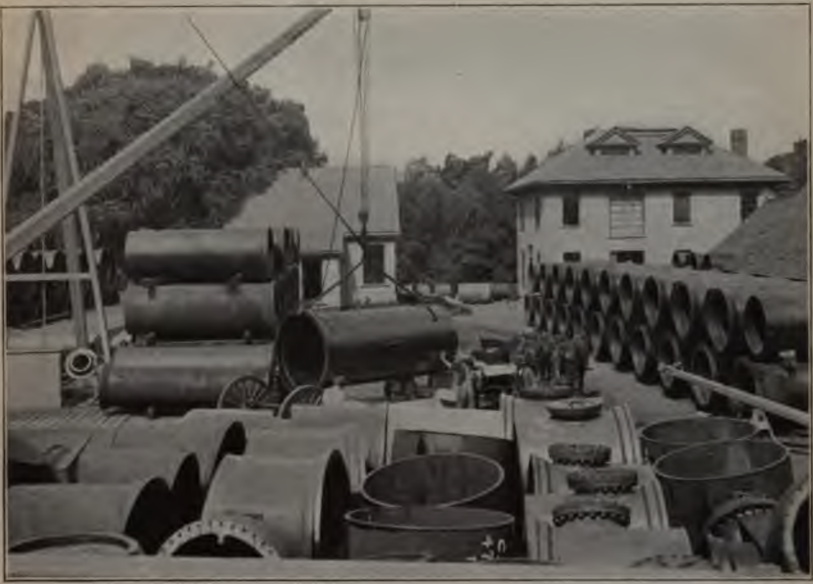
| | |
|---|---|
| Engineering, . . . . . . . . . . . . | $5,720 59 |
| Pipes and special castings, . . . . . . . . . | 95,912 75 |
| Valves and valve chambers, . . . . . . . . | 9,640 94 |
| Laying pipes by contract, . . . . . . . . . | 37,996 06 |
| Resurfacing streets in Brookline, . . . . . . . | 4,653 63 |
| Changing location of pipes of Brookline Water Works, . . | 542 21 |
| Stock and labor on connection with existing pipes, . . . | 8,231 88 |
| | $162,698 06 |

### 60-inch Supply Pipe Line.

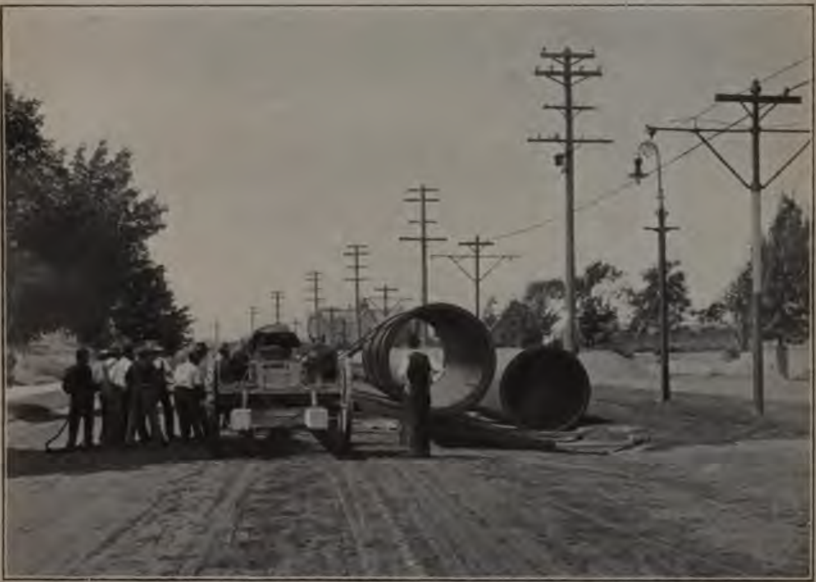
The Legislature of the year 1909 authorized the expenditure of $750,000 for constructing a pipe line for the purpose of bringing additional water from the Weston Aqueduct into the Metropolitan District. The work to be done involves the laying of about 32,250 feet of 60-inch cast-iron pipe and the construction of a pressure tunnel 6 feet 4 inches in diameter, 1,900 feet long, and a cement-lined and concrete-covered steel pipe 6 feet 4 inches in diameter and 500 feet long.

Contracts for furnishing 8,000 tons of 60-inch pipe were made about the middle of May with the United States Cast Iron Pipe and Foundry Company of New York, N. Y., and the Florence Iron Works of Camden, N. J., and for 200 tons of special castings with the Standard Cast Iron Pipe and Foundry Company of Bristol, Pa. The value of work done under these contracts on December 31 was approximately $142,070.

On August 18 a contract was made with the Charles J. Jacobs Company for laying about 8,000 feet of this pipe, extending from the corner of Beacon Street and Chestnut Hill Avenue, in Brighton, through Chestnut Hill and Commonwealth avenues, and through land of the Commonwealth alongside the Cochituate Aqueduct to a point near the ventilating chamber of the aqueduct in Newton. Trench excavation under this contract was begun on August 26, pipe



CHESTNUT HILL PIPE YARD—LOADING 60-INCH PIPE.



UNLOADING 60-INCH PIPE ON PIPE LINE IN BRIGHTON.

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laying on September 1, and the work was continued with an average force of 87 men until December 24, when active operations were suspended for the season. The value of the work done under this contract on December 31 was $25,902.53, which includes the laying of 5,349 feet of 60-inch pipe and the excavation of 2,518 cubic yards of rock.

Joints of wood, in place of the ordinary lead joint, have been placed in this pipe line at intervals of about 500 feet, for the purpose of reducing the amount of electric current flowing on the pipe line. The construction of the pressure tunnel and the laying of about 9,800 feet of 60-inch pipe will be contracted for early in the coming year.

### 24-inch Northern High-service Pipe Line in Everett, Revere and Chelsea, Section 33.

At times during the summer season when the use of water for street and lawn sprinkling was very large the main supplying water to the towns of Winthrop, Revere, Swampscott and Nahant has for several years been of inadequate size to supply the quantity of water used without undue loss of pressure, and to remedy this condition the existing main has been reinforced by laying a 24-inch main from the junction of Broadway and Hancock Street, in Everett, through Broadway, High, Foster, Arlington and Nichols streets, in Everett; Nichols Street, Washington Avenue and Fenno Street, in Chelsea, and Fenno Street, in Revere, to the junction of Broadway, a distance of 12,326 feet.

A contract for furnishing pipe and special castings required for this work was made with the Standard Cast Iron Pipe and Foundry Company of Bristol, Pa., on May 7, and a contract for laying the pipe was made with Camoia & Williams of Boston, on July 16.

The contractors began the work of laying pipe on July 20 and completed the pipe laying on December 17. The force employed averaged 44 men.

All connections between this main and the existing main were made by the maintenance force. A portion of the main between Murray Street, in Chelsea, and Broadway, in Revere, about 6,585 feet in length, was placed in service on December 9, and the remaining portion was first used on December 30.

The immediate effect of the use of this main was to increase the pressure near the junction of the pipe lines supplying Nahant and Swampscott about 5 pounds per square inch. The effect during the summer season, when the consumption is large, will be much greater. The final payments for laying the pipes have not been made, but the cost of the whole work will vary but little from $59,200.

### 16-INCH PIPE LINE FOR THE SUPPLY OF WINTHROP, SECTION 32.

This main, 3,945 feet long, extending from near the Beachmont Station of the Boston, Revere Beach & Lynn Railroad, in Revere, through Winthrop Avenue to the Winthrop town line, has been laid to improve the supply in the town of Winthrop and takes the place of a 12-inch main belonging to the town of Revere, which has heretofore been used for the supply of Winthrop.

The laying of this pipe was commenced by Camoia & Williams, contractors for the work, on August 4, and carried on with a force of from 21 to 56 men. The work of the contractors was completed on September 25, after which the connections with the existing mains were made by the maintenance force, and the new main was placed in service on October 23. The cost of the work, including labor and materials, was $12,500.

### NORTHERN EXTRA HIGH-SERVICE PIPE LINE TO BELMONT, SECTION 34.

In order that buildings on the higher land in Belmont may be supplied from the Metropolitan Works, a 12-inch pipe line, 1,610 feet in length, has been laid from the standpipe on Arlington Heights through Park Avenue, in Arlington, to the Belmont line. This work, with the exception of the connections, was done by Angelo De Marco & Co., under a contract made on August 12. The connections with existing mains were made by the maintenance force and the line put in service on November 18. A 6-inch Hersey detector meter, model F.M., with a 3-inch meter on the by-pass, was set on Park Avenue at the Belmont line. This meter automatically registers the ordinary domestic consumption of a few takers as well as the larger quantity required in case of fire. The cost of this work was $4,604.43.

### Pumping Engine for the Southern High Service.

On September 21 a contract was made with the Holly Manufacturing Company of Buffalo, N. Y., for the construction and erection, at the low-service pumping station at Chestnut Hill, of a triple expansion, crank and fly-wheel pumping engine, having a capacity of 40,000,000 gallons in twenty-four hours, for the sum of $99,769. The making of detailed drawings of the engine has been in progress for several months and construction work has been recently commenced. The contract calls for the completion of the work before March 12, 1911.

### Miscellaneous.

At the Wachusett Dam inscriptions have been cut in the granite gate posts at the Boylston Street entrance, and two bronze tablets have been placed on the exterior face of the lower gate-chamber briefly setting forth historical facts relative to the Metropolitan Water Works, particularly the Wachusett Reservoir. The cutting of the inscriptions cost $228.80, and the two tablets cost $425.

A tile floor has been laid in the exciter room at the lower gate-house at the Wachusett Dam, at a cost of $203.37.

The maintenance force has unloaded from cars about 9,840 tons of pipes as received from the foundries, and loaded 7,310 tons on teams of contractors who have laid the pipes. On account of lack of storage room at the Chestnut Hill pipe yard, and in order to shorten the length of haul, arrangements have been made with the Boston & Albany Railroad for the use of land near the Woodland Station, in Newton, for use in storing 60-inch pipes, and since November 24 the pipes have been received and stored at that point. About 350 tons of pipe which are to be laid to reinforce the supply in Swampscott were inspected and unloaded, and are now stored on land near the Swampscott Station of the Boston & Maine Railroad.

### Engineering.

The work of the engineering force in connection with construction has included the preparation of plans and specifications for the purchase of pipes, valves and other materials for use in connection with the several pipe lines which have been under construction; the supervision of the several contracts for pipe laying; the preparation of specifications and the examination of plans for the new pumping engine at the Chestnut Hill Station; the making of surveys, plans and estimates of cost of new mains for the supply of East Boston, Arlington and Lexington; and the making of surveys and borings to determine the most economical plan for a tunnel on the line of the 60-inch main in Newton. Considerable time has been spent upon record plans of completed work.

## MAINTENANCE.

### Rainfall and Yield.

The rainfall on the several watersheds for the whole year was from 3.5 to 4 inches below the average. During the latter half of the year the rainfall was about 5 inches less than the average for the corresponding period but not as low as during the previous year. The yearly total on the Wachusett watershed was 44.50 inches and on the Sudbury watershed 41.75 inches.

Statistics relating to the rainfall and yield of watersheds may be found in Appendix No. 4, tables Nos. 1 to 8.

### Storage Reservoirs.

The quantity stored in all the storage reservoirs on January 1, 1909, was 58,890,300,000 gallons. During January, and until February 9, the yield of the watersheds was less than the consumption and the amount of storage was reduced to 57,300,000,000 gallons. During the following three months the rainfall exceeded the average and on May 10 the quantity stored had risen to 78,406,000,000 gallons. The maximum storage was on June 14, when the reservoirs contained 79,112,800,000 gallons, which was very nearly the same as the quantity stored on the corresponding date in 1908. There was an almost continual loss of storage from the middle of June until December 31, although the loss during the last three months of the year was less than in 1908, and at the close of the year the quantity stored was 62,101,500,000 gallons, or 3,211,200,000 gallons more than at the beginning of the year.

The following table gives the quantity of water stored in the storage reservoirs at the beginning of each month: —

*Quantity of Water stored in Wachusett Reservoir, and in Reservoirs on Sudbury and Cochituate Watersheds, at the Beginning of Each Month.*

| DATE. | In Wachusett Reservoir (Gallons). | In Sudbury Reservoir and Framingham Reservoir No. 3 (Gallons). | In All Other Storage Reservoirs (Gallons). | Total (Gallons). |
|---|---|---|---|---|
| **1909.** | | | | |
| January 1, | 46,176,000,000 | 6,495,300,000 | 6,219,000,000 | 58,890,300,000 |
| February 1, | 44,405,700,000 | 7,207,600,000 | 6,189,900,000 | 57,803,200,000 |
| March 1, | 51,397,300,000 | 7,004,200,000 | 7,011,200,000 | 65,412,700,000 |
| April 1, | 56,174,400,000 | 7,544,400,000 | 7,065,500,000 | 70,784,300,000 |
| May 1, | 62,215,400,000 | 7,903,000,000 | 7,207,000,000 | 77,325,400,000 |
| June 1, | 63,692,600,000 | 7,892,100,000 | 7,243,900,000 | 78,828,600,000 |
| July 1, | 63,012,200,000 | 7,926,700,000 | 6,923,500,000 | 77,862,400,000 |
| August 1, | 60,461,500,000 | 7,913,600,000 | 6,165,300,000 | 74,540,400,000 |
| September 1, | 57,900,700,000 | 7,891,800,000 | 5,620,900,000 | 71,413,400,000 |
| October 1, | 57,054,400,000 | 6,555,400,000 | 5,459,200,000 | 69,069,000,000 |
| November 1, | 54,453,500,000 | 5,694,700,000 | 5,379,000,000 | 65,527,200,000 |
| December 1, | 50,063,900,000 | 7,836,000,000 | 5,443,400,000 | 63,343,300,000 |
| **1910.** | | | | |
| January 1, | 48,667,800,000 | 7,806,400,000 | 5,627,300,000 | 62,101,500,000 |

*Wachusett Reservoir and Dam.* — At the beginning of the year the water in this reservoir was 15.13 feet below high-water mark and the reservoir contained 46,176,000,000 gallons. The reservoir reached its lowest level on February 6, when it was 17.08 feet below high-water mark; from this time until June 14 there was a gradual and practically continuous rise in the elevation of the reservoir surface, the maximum elevation for the year being 394.4 feet, or 0.6 of a foot below high water, and the reservoir contained 64,161,000,000 gallons. The only water discharged from the reservoir into the river below the dam was that required for the use of the Lancaster Mills. This quantity was measured by Venturi meters at the dam, and averaged 2,536,000 gallons per day for the whole year.

The action of the waves on the shores of the reservoir has made necessary the stripping of soil on the north shore at Kendall Cove, and on the south shore between Sawyer's Mills Bluffs, in Boylston, and Pine Hill, in West Boylston. The strip from which soil was removed was from 6 to 20 feet in width for a length of 5,000 feet

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and had an area of 1.46 acres. The amount expended on this work was $614.83. During the latter portion of the year, while the shores of the reservoir were exposed to a depth of from 8 to 10 feet below high water, the roots, stumps and miscellaneous débris which had been uncovered by the action of the waves were collected and burned.

Driftwood which had accumulated during the past two years along the shores of the Quinepoxet and Stillwater rivers, for a distance of 4,000 feet above the reservoir, was also collected and burned.

A motor scow 30½ feet long and 9 feet wide, having a carrying capacity of 7.5 tons, and operated by a 10 horse-power gasolene motor, was designed by the engineering department and built by the maintenance force during the early part of the year at a cost of $799.92. It has been used with very satisfactory results during the past season for transporting men and supplies about the reservoir.

During the spring and fall about 36 acres of grass land on the back slopes of the North and South dikes were fertilized with 646 cubic yards of sludge collected in the settling tanks at the Clinton sewerage filter-beds, at a cost of $655.92; and 256 cubic yards of the sludge were spread on the grounds below the dam, at a cost of $259.94.

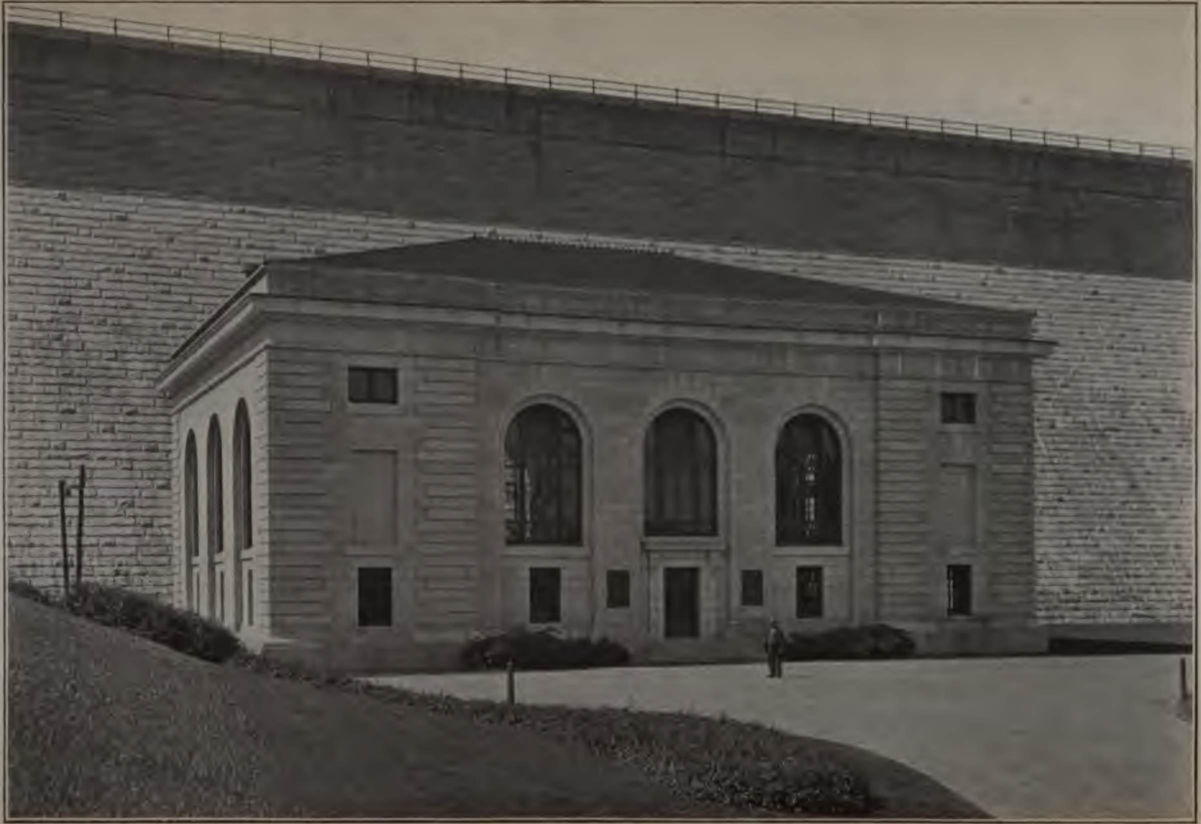
The grass on about 350 acres of land on the North and South dikes, along the shores of the reservoir and on outlying parcels of land has been sold for the sum of $2,347.50. Brush and weeds have been mowed and burned on the 50-foot margin of the reservoir for a distance of about 30 miles, at a cost of $1,168.70, or $38.96 per mile. Six stone monuments, marked with the initials of the towns, have been set near the shores of the reservoir to mark the town boundary lines at the following locations: On the crest of the South Dike, between the towns of Clinton and Boylston; on the crest of the westerly portion of the North Dike, between the towns of Clinton and Sterling; on the shore of Prescott Cove, between the towns of Sterling and Boylston; on the south shore of the reservoir near Pine Hill, between the towns of Boylston and West Boylston; on the northerly shore of the west arm of South Bay, between the towns of Boylston and West Boylston, and on the easterly shore of Stillwater Basin, between the towns of West Boylston and Sterling.

The iron guard fences on the bridges over the reservoir at Beaman and Thomas streets, West Boylston, have been cleaned and painted.

The Connecticut River Transmission Company has, by permission of the board, crossed the Wachusett Reservoir and lands on either

RARY

ATIONS.



WACHUSETT DAM — GATE AND POWER HOUSE.

side, for a distance of 7,130 feet, with lines of wires to be used in transmitting electricity under a pressure of 66,000 volts from a power plant located on the Connecticut River near Brattleboro, Vt., to the city of Worcester, Mass., and has also crossed the North Dike and other lands near the Wachusett Dam with a line of wooden poles and wires 6,100 feet long, carrying current under a pressure of 13,200 volts to the Lancaster Mills, the city of Marlborough, and the towns of Berlin, Shrewsbury, Northborough, Westborough and Southborough. The line to Worcester crosses the reservoir about 500 feet east of the Worcester Street Bridge by six steel cables, ¾ of an inch in diameter, 1,970 feet long, suspended from steel towers 30 feet square at the base and 75 feet high. There is one tower on the north side of the reservoir 60 feet high and 25 feet square at the base, and the remaining eleven towers are 40 feet high and 14 feet square at the base, spaced about 350 feet apart, and support six No. 2 copper cables, each cable consisting of seven strands of No. 10 wire. The towers also support two telephone wires and one guard wire for protection from lightning. For the privilege of maintaining this line the Company has agreed to pay $300 per annum, and to keep a strip of land 40 feet in width free from tall grass, weeds and underbrush.

The line leading to the Lancaster Mills is constructed with chestnut poles about 40 feet long, spaced from 100 to 125 feet apart, supporting six No. 2 copper cables for the transmission of power current, two telephone wires and a guard wire. For the privilege of maintaining this line the Company will pay $100 per annum.

On November 3 the headquarters of the Wachusett Department were moved from the building on Walnut Street, in Clinton, to the lower gate-chamber at the dam. Before making this change it was necessary to install sanitary conveniences, extend the electric lighting system, and do considerable carpenter work and painting. The telephone and electric light wires between Boylston Street and the gate-chamber, a distance of about 470 feet, were placed underground in two lines of Orangeburg fiber conduit. The total cost of fitting the rooms in the lower gate-chamber, moving the furniture, plans, etc., from the Walnut Street office, and laying underground conduit, was $1,693.04.

Such repairs as were necessary to keep in good condition the 14 houses belonging to the Board have been made from time to time, the principal ones being as follows: Slating the house, barn and sheds on the Henry Marsh property, in Oakdale, occupied by foreman Bray, using slate secured from buildings on property leased to William B. Woods, in West Boylston, and building a carriage shed with lumber secured from old buildings on the Anna E. Russell property; remodeling and repairing large store-house and blacksmith shop at the Wilson Street storage yard; painting, whitewashing and papering at the Cutting, Lamson and Tucker houses in Boylston, at the Eckstein and Kramer houses in Clinton, and at the Lalone and C. McLean houses in Lancaster; repairing chimneys on the A. McLean house in Lancaster, and on the Eckstein, Kramer and Beaven houses in Clinton. These houses are rented.

On the afternoon of August 27 the house and barn on the Livingston property on Mill Street, Lancaster, were destroyed by fire. The grounds at this place have been since cleaned and left in a safe and neat condition.

The buildings on land acquired from Anna E. Russell, in Oakdale, and from Willie R. Mitchell, in Sterling, have been sold and removed from within the limits of the watershed. The house and barn on land purchased from Tennis and Louisa Dugas, at Sterling Junction, were disposed of by them in accordance with the terms of purchase. Cellar holes on these three properties have been filled and the adjacent grounds have been cleaned and left in a neat and sanitary condition.

Two parcels of land have been leased by the Board for pasturage purposes, one containing 16 acres at Sterling Junction, and one containing 10 acres at Oakdale. The aggregate receipts for the year were $25.

A right was sold to the town of Boylston to take sand and gravel from an area containing 0.25 of an acre near the Six Nations schoolhouse lot.

During the year 109 stone monuments and 11 iron bolts have been set and 20 stone monuments reset, for the purpose of permanently marking the corners of property around the Wachusett Reservoir, on the Wachusett watershed and along the Wachusett Aqueduct where bounds had not been previously placed.

*Sudbury Reservoir.* — All the water supplied to the Metropolitan

District from the Wachusett Reservoir passes through the Sudbury Reservoir and its level is largely controlled by the manipulation of the gates controlling the flow through the Wachusett Aqueduct. At the beginning of the year this reservoir was 3.23 feet below the stone crest of the dam, and it was kept between ½ of a foot and 3 feet below the crest until April 2, after which date the water flowed over the crest until September 17. During the following month the reservoir was lowered nearly 6 feet for the purpose of facilitating the work of improving the Southborough swimming pool, and after that work was completed was again filled, and water flowed over the crest of the dam from November 24 to the end of the year.

At the request of the town of Southborough improvements have been made at the swimming pool, which was constructed in 1908. For the purpose of making it more convenient and safe for the bathers the deeper portion of the pool was filled so that its greatest depth is now about 6 feet, and the slope of the shore on one side of the pool was flattened to a slope of 8 horizontal to 1 vertical below the water line, and 4 horizontal to 1 vertical above the water. The slope was covered to a depth of eight inches with clean sharp sand. The material excavated was used in grading the land on the south side of the pool so as to divert the surface drainage from the adjoining hillside away from the swimming pool into the reservoir. The cost of this improvement was $393.33, one-half of which was paid by the town of Southborough. The town has also provided proper sanitary conveniences for the bathers and has constructed a fence at the westerly end of the pool to screen the bathers from public view. A bath house has been constructed at the expense of Mr. Robert M. Burnett and given to the town. Five hundred pine trees have been planted on the grounds, and when grown these trees will completely hide the pool from view from the highways.

The ledge at the foot of the masonry overflow at the Sudbury Dam contains seams of slaty rock which has disintegrated during the past ten years, through the action of frost and water flowing over the dam. To prevent further wearing away of the rock, and the loosening of the paving at the foot of the dam, about 50 cubic yards of Portland cement concrete were placed in the larger cavities and open joints in the paving and the seams in the rock were pointed. The cost of this work was about $500.

The dwelling house at the dam was given two coats of paint and the barn and shed one coat, and the house at the Cratty place, in Fayville, was given one coat of paint. Cellars from which houses have been removed on the Ransom and Ball places were filled and the ground graded. Some grading has been done on wood roads which are being built on the north and south sides of the reservoir, when opportunity offers.

*Framingham Reservoir No. 3.* — The elevation of the water in this reservoir is controlled by drafts from the Sudbury Reservoir and its surface was maintained from 0.15 of a foot to 4.55 feet below the crest of the overflow throughout the year. No water was allowed to waste from the reservoir into Framingham Reservoir No. 1. About 4,000 feet of Wheelock wire fence were built between property of the Board and Alfred N. Thompson on the north side of the reservoir, and Thomas Sampson and Andrew Stensson on the south side of the reservoir, to prevent cattle from obtaining access to the water. This fence is constructed with six No. 9 wires stretched horizontally between chestnut posts set 12 feet apart, and between each pair of posts four No. 8 vertical rods are securely clamped to the horizontal wires at each intersection, making a rigid fence.

*Framingham Reservoir No. 2.* — Water was drawn from this reservoir for use in the Metropolitan District from January 7 to February 12. During the remainder of the year water was wasting over the dam during the greater portion of the time.

*Framingham Reservoir No. 1.* — The water in this reservoir was above the level of the crest of the dam throughout the year, with the exception of a few days in January and until the last of June water was allowed to waste in addition to the 1,500,000 gallons per day which the law requires shall constantly flow into the river below the dam. During the succeeding four months but little water was wasted, and during the last two months of the year small quantities were wasted during the greater portion of the time.

*Ashland Reservoir.* — No water was drawn from this reservoir for the supply of the Metropolitan District. On January 1, 1909, the water was 0.13 of a foot above the crest of the overflow and the reservoir remained substantially full throughout the year. The bridge over the waste-way channel was rebuilt.

*Hopkinton Reservoir.* — At the beginning of the year water in this reservoir was above the crest of the overflow. From January 13 to February 12 water was drawn from the reservoir for the supply of the District and its surface was lowered 4½ feet. It was again full on February 27 and remained full throughout the remainder of the year. A 6-strand Wheelock wire fence 1,270 feet long was built on the line between property of the Commonwealth and Julia Raftery, to replace a fence destroyed by a forest fire. Fences were built for a distance of about 400 feet on each side of the public road which crosses the upper end of the reservoir. These were constructed with chestnut posts set 8 feet apart and three longitudinal 2-inch x 5-inch spruce rails. The filter-beds were cleaned in the spring and weeded in the fall.

*Whitehall Reservoir.* — This reservoir was practically full throughout the year as it was not drawn upon for the supply of the Metropolitan District. Five new cottages were built by owners of land near the reservoir, making the total number at the end of the year 43. There were in use during the season 13 motor boats, 2 sailboats, 45 rowboats and 19 canoes, a total of 79 boats of all kinds, as compared with 87 for the previous year.

*Farm Pond.* — No water was turned into this pond from the reservoirs on the Sudbury River, and no water was drawn from the pond for the use of the District. The town of Framingham has drawn the greater portion of its supply from the filter-gallery alongside the pond, but during each month of the year, with the exception of the months of March and May, has drawn some water directly from the Sudbury Aqueduct.

*Lake Cochituate.* — The water in the lake at the beginning of the year was 2.58 feet below high-water. On February 18 the water was but a few inches below high-water mark and the waste gates were opened at the dam. Water was allowed to waste until June 4. On June 6 the lake was drawn upon for the supply of the Metropolitan District, and a continuous draft of about 20,000,000 gallons per day during the succeeding four months lowered its surface 8 feet. During the latter part of September the water acquired an objectionable taste and odor, due to a growth of microscopic organisms, and its use was discontinued during the remainder of the year. As a result the surface gradually rose, and at the end of the year was 5.6 feet below high water.

During the year several improvements have been made and plans for further improvements prepared for the purpose of protecting the purity of the water and improving the existing conditions around the lake shores. Strips of land have been acquired at several points for the purpose of increasing the width of the margin of land controlled by the Board. Wheelock wire fencing aggregating 3,012 feet in length has been built adjoining property of Abbott Whitcomb and R. G. Bayer *et al.* for the purpose of preventing cattle from obtaining access to the water. Four coves where the water was shallow when the lake was full, and the resulting growth of aquatic vegetation presented a somewhat objectionable appearance, have been filled with material excavated from the bed of the lake. The largest of these areas, located in the northerly section of the lake, between Lyon's island and the easterly shore, covered an area of 47,300 square feet, and its improvement required the moving of about 3,600 cubic yards of material, at a cost of 26 cents per cubic yard. An area of 17,400 square feet on the west shore of the lake, adjoining land belonging to the heirs of Willard Morse, was filled with 1,700 cubic yards of material, at a cost of 33 cents per cubic yard. One of the small coves was located on the west shore of the lake, at the southern end, near the Boston & Albany Railroad, and another on the east shore just north of the effluent gate-house. In all four of these cases the sand and gravel, mixed in some cases with clay, was moved with wheeled scrapers and carts, and the surface of the material in the coves was left slightly more than 1½ feet above high-water mark. The cost of the work done at the four coves was $1,782.67.

During the early part of the year surveys and plans were made for the construction of works for the diversion of the surface drainage of the village of Cochituate from Snake Brook, which flows into Lake Cochituate, into Banister's Brook, which discharges into the Sudbury River. Proposals for constructing these works were received on October 4, but as the lowest price bid indicated that the cost of the whole work would exceed the amount appropriated by the Legislature it was deemed advisable to reject all bids and postpone the work until another season. It was thought advisable, however, to take advantage of the low stage of the water in the lake to place a pipe across the culvert between the north and middle divisions of the lake, and 32½ feet of 36-inch cast-iron pipe, which will eventually form a portion of the proposed channel, was laid by the maintenance force, *at a cost of $423.90.*

No boats were allowed on the lake during the past season and there was no increase in the number of cottages.

No water was drawn from Dudley Pond during the year, and its elevation ranged between 2.22 feet below high water in May, and 4.15 feet below in November. Three new cottages were built on the shores of the pond during the year, making 22 at the present time.

Under authority given by chapter 282 of the Acts of 1909 the control of Dug Pond has been transferred to the town of Natick and the connections between the pond and Lake Cochituate have been closed. The 24-inch brick conduit and the 18-inch Akron pipe, which were the channels between the pond and the lake, were permanently closed with concrete during the month of July. Some water flowed into the lake from the pond during March, April, May and June. After July 10 there was no flow into the lake and the work of closing the connection was completed on July 27. The town of Natick has excavated a channel from the south end of the pond leading into the watershed of the Charles River. This channel is about 230 feet long, 2 feet wide at the bottom, with a maximum depth of 5 feet. The invert of the channel is at grade 153.75. The elevation of the invert of the old outlet at the north end of the pond was 152.36.

## SOURCES FROM WHICH WATER FOR THE SUPPLY OF THE METROPOLITAN DISTRICT HAS BEEN TAKEN.

An average of 99,312,000 gallons per day was drawn from the Wachusett Reservoir through the Wachusett Aqueduct into the Sudbury Reservoir. An average of 29,440,000 gallons per day was drawn from the Sudbury Reservoir through the Weston Aqueduct into the distributing system of the Metropolitan District. From Framingham Reservoir No. 2 an average of 2,467,000 gallons per day and from Framingham Reservoir No. 3 an average of 81,046,000 gallons per day were drawn through the Sudbury Aqueduct. From Lake Cochituate an average of 6,774,000 gallons per day was drawn through the Cochituate Aqueduct to Chestnut Hill Reservoir. The Spot Pond drainage area furnished 290,000 gallons per day. No water was drawn from the Ashland and Whitehall reservoirs during the year.

## AQUEDUCTS.

The *Wachusett Aqueduct* was in use 7,340 hours, equivalent to 305.8 days, during the year. The masonry portion of the aqueduct was not cleaned during the year. The upper end of the open channel was cleaned for a distance of 4,070 feet by removing the weeds and water grasses, which had attained such a growth as materially to retard the flow of the water. This work was done while the channel was emptied to facilitate the work of laying the inlet pipe for the supply of the Westborough Insane Hospital. Repairs have been made at the upper and lower dams of the open channel, consisting of cleaning and pointing the masonry joints, scraping and painting the iron flashboard supports and fences and painting the plank bridges. The iron fences on the Assabet Bridge and on all bridges crossing the open channel have been cleaned and painted. Six-strand Wheelock wire fencing, 6,157 feet in length, has been constructed along portions of the open channel and aqueduct land where cattle were being pastured on the adjoining property.

The *Sudbury Aqueduct* was in continuous use throughout the year. Extensive repairs have been made upon the exterior brick masonry of the Echo Bridge, upon which the aqueduct crosses the Charles River between Newton and Wellesley. During the thirty-three years since this bridge was built the exposed brickwork on both sides of the bridge had become disintegrated, so that it was necessary to repoint, or to take down and relay, the brickwork over a surface of about 740 square yards. The joints in the upper and lower belt courses of granite and in the flat surface of the landings on the east and west abutments were pointed with elastic cement. A force of 8 masons and from 1 to 2 laborers was employed in making these repairs from August 16 to November 17, and the total cost of labor and materials was $3,730.

The joints in the granite masonry on the north side of the substructure of Bacon's waste-weir and in the sandstone at the entrance to Clark's waste-weir were repointed. The iron railings, stairways and manhole covers at the Waban and Echo bridges, the iron gratings and floor beams at the Course Brook waste-weir and the doors of the siphon chambers at Rosemary Brook were painted. Considerable work has been done for the purpose of improving the sod on the slopes of the aqueduct embankments. This work has consisted of spreading loam, grass seed and 18¼ tons of wood ashes on the surface of the higher embankments.

A concrete conduit 18 inches square, containing four 3-inch ducts, was laid over the aqueduct at Boylston Street, Newton, by the Edison Electric Illuminating Company.

The *Cochituate Aqueduct* was in use 3,012 hours, equivalent to 125.5 days. The interior of the aqueduct, for a distance of 1½ miles from the pumping station at Chestnut Hill, was cleaned in May and again in December. The remainder of the aqueduct was not cleaned during the year. Considerable work has been done along the line of the aqueduct in cutting and burning dead and undesirable trees and brush. Five tons of wood ashes were spread on the large embankments for the purpose of improving the sod. Wheelock wire fencing 300 feet long was erected on the property line between land of the Commonwealth and Francis Fitts, in Newton.

Concrete conduits have been constructed by the Edison Electric Illuminating Company over the aqueduct at the following points: One 6-inch x 16-inch conduit, containing two 3-inch ducts, at Worcester Street in Wellesley, near Dedman's Brook waste-weir, and one 14-inch x 20-inch conduit, containing four 3-inch ducts, at Worcester Street near Wellesley Hills Square.

The city of Newton began, but has not completed, the laying of a 24-inch surface-water drain over the aqueduct near Endicott Street, Newton Highlands. For a length of about 50 feet iron pipes with leaded joints will be used for this work, the remainder being Akron pipe.

The *Weston Aqueduct* was in service 8,625.5 hours, equivalent to 359.4 days. Considerable work has been done in spreading loam, seeding and fertilizing the aqueduct embankments. Seventeen tons of wood ashes were used for this work. Galvanized iron caps on the chimneys at the head-house at the Sudbury Dam, at gaging chamber No. 1 and at the four siphon chambers have been replaced by concrete caps, which are expected to be more durable. The house and barn at the White place, in Framingham, and the house occupied by the attendant at the Weston Reservoir have been painted.

### PUMPING STATIONS.

Seventy-five per cent. of the water supplied to the Metropolitan District has been pumped at the two stations at Chestnut Hill Reservoir; the remainder was delivered by gravity. The total quantity pumped at all of the stations during the year was 35,762,190,000 gallons, which was 8.7 per cent. less than during the preceding year. The cost of operating the stations was $106,902.03, equivalent to $2.989 per million gallons pumped, or $0.055 less than the corresponding cost during the year 1908. The average cost of raising 1,000,000 gallons of water 1 foot high at all of the stations was $0.0349, which is slightly less than the cost during the previous year. Coal for use at the several stations has been purchased as follows: —

| By whom furnished. | Gross Tons. | | | | | Price per Gross Ton, in Bins.[1] |
|---|---|---|---|---|---|---|
| | Chestnut Hill High-service Station. | Chestnut Hill Low-service Station. | Spot Pond Station. | West Roxbury Station. | Arlington Station. | |
| Spring Coal Company, bituminous, | 2,001.12 | – | – | – | – | $4 19 |
| Spring Coal Company, bituminous, | – | 1,135.49 | – | – | – | 4 06 |
| Logan Coal Company, bituminous, | 20.00 | – | – | – | – | 4 00 |
| Spring Coal Company, bituminous, | 2,212.30 | – | – | – | – | 3 98 |
| Maryland Coal and Coke Company, bituminous. | 41.07 | – | – | – | – | 3 97 |
| Spring Coal Company, bituminous, | – | 1,066.21 | – | – | – | 3 86 |
| Bader Coal Company, bituminous, | 36.96 | – | – | – | – | 3 85 |
| C. W. Claflin & Co., buckwheat anthracite, | 1,639.19 | – | – | – | – | 2 73 |
| C. W. Claflin & Co., buckwheat anthracite, | – | 1,362.91 | – | – | – | 2 61 |
| New England Coal and Coke Company, bituminous. | – | – | 400.25 | – | – | 4 25 |
| New England Coal and Coke Company, bituminous. | – | – | 197.47 | – | – | 4 19 |
| Locke Coal Company, screenings, | – | – | 371.61 | – | – | 2 50 |
| Locke Coal Company, screenings, | – | – | 108.71 | – | – | 2 24 |
| New England Coal and Coke Company, bituminous. | – | – | – | – | 160.01 | 4 04 |
| New England Coal and Coke Company, bituminous. | – | – | – | – | 136.91 | 3 86 |
| Philadelphia and Reading Coal and Iron Company, screenings. | – | – | – | – | 123.40 | 2 66 |
| J. A. Whittemore's Sons, egg, | – | – | – | 101.85 | – | 6 83 |
| J. A. Whittemore's Sons, furnace, | – | – | – | 5.35 | – | 6 56 |
| Metropolitan Coal Company, furnace, | – | – | – | 95.41 | – | 6 27 |
| Metropolitan Coal Company, pea, | – | – | – | 5.36 | – | 5 88 |
| J. A. Whittemore's Sons, pea, | – | – | – | 3.57 | – | 5 88 |
| Roxbury Coal Company, pea, | – | – | – | 3.57 | – | 5 60 |
| Metropolitan Coal Company, pea, | – | – | – | 113.05 | – | 5 04 |
| Total gross tons, bituminous, | 4,311.45 | 2,201.70 | 597.72 | – | 296.92 | – |
| Total gross tons, anthracite, | 1,639.19[2] | 1,362.91[2] | – | 328.16 | – | – |
| Total gross tons, anthracite screenings, | – | – | 480.32 | – | 123.40 | – |
| Average price per gross ton, bituminous, | $4 08 | $3 96 | $4 23 | – | $3 96 | – |
| Average price per gross ton, anthracite, | 2 73[2] | 2 61[2] | – | $6 01 | – | – |
| Average price per gross ton, anthracite screenings. | – | – | 2 44 | – | 2 66 | – |

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[1] Includes cost of unloading coal from cars and all expenses incidental to storage of the coal.

[2] Buckwheat.

Contracts under which bituminous coal has been purchased have specified that the coal should contain approximately 14,200 British thermal units, 18 to 20 per cent. of volatile matter, 8 per cent. of ash and 1 per cent. of sulphur. Coal which when dry contains more than 12 per cent. of ash, 23 per cent. of volatile matter or 1.75 per cent. of sulphur is subject to rejection.

Payments for the coal have been made on the basis of the price bid, corrected for variation in the heating value and percentage of ash, as determined by samples of the coal delivered, an addition being made in cases where the number of British thermal units has exceeded 14,200 and a deduction when the number has fallen below 14,000, or the amount of ash has exceeded 9 per cent. A deduction has also been made when the amount of moisture in the coal as received has exceeded 4 per cent. The average results of the tests of bituminous coals are given in the following table, including coal purchased for both the Water and Sewerage Works. The quality of the coal received has in general been better than was received during the previous year.

| KIND OF COAL. | Number of Samples tested. | British Thermal Units. | Percentage of Volatile Matter. | Percentage of Ash. | Percentage of Moisture. |
|---|---|---|---|---|---|
| **Davis,** . . . . . . . | 99 | 14,356 | 21.91 | 6.97 | 2.39 |
| **Vulcan,** . . . . . . . | 83 | 14,577 | 20.75 | 6.29 | 2.57 |
| **New River,** . . . . . . | 14 | 14,800 | 21.60 | 5.20 | 3.17 |
| **Pocahontas,** . . . . . . | 11 | 14,804 | 18.89 | 5.42 | 2.43 |
| **Java Mine,** . . . . . . | 6 | 13,949 | 16.49 | 10.34 | 2.73 |
| **Georges Creek,** . . . .. . | 4 | 14,279 | 19.14 | 7.12 | 2.67 |

### *Chestnut Hill High-service Station.*

At this station water is pumped for use in the high-service district of Boston, the city of Quincy and the towns of Watertown, Belmont and Milton.

The following are the statistics relating to operations at this station: —

| | Engines Nos. 1 and 2. | Engine No. 3. | Engine No. 4. | Totals for Station. |
|---|---|---|---|---|
| Total quantity pumped (million gallons), . . | 1,321.95 | 1,404.59 | 10,708.46 | 13,435.00 |
| Daily average quantity pumped (gallons), . . | 3,622,000 | 3,848,000 | 29,338,000 | 36,808,000 |
| Total coal used (pounds), . . . . . . . | 2,124,272 | 1,565,681 | 8,625,393 | 12,315,346 |
| Gallons pumped per pound of coal, . . . . | 622.31 | 897.11 | 1,241.50 | 1,090.92 |
| Average lift (feet), . . . . . . . . | 120.04 | 127.84 | 130.25 | 129.02 |
| Cost of pumping: — | | | | |
| Labor, . . . . . . . . . . . | $3,549 10 | $3,169 64 | $15,602 64 | $22,321 38 |
| Fuel, . . . . . . . . . . . . | 3,480 07 | 2,690 74 | 14,683 81 | 20,854 62 |
| Repairs, . . . . . . . . . . . | 286 75 | 502 10 | 1,343 39 | 2,132 24 |
| Oil, waste and packing, . . . . . . . | 96 14 | 85 86 | 422 65 | 604 65 |
| Small supplies, . . . . . . . . . | 89 95 | 80 34 | 395 47 | 565 76 |
| Totals, . . . . . . . . . . | $7,502 01 | $6,528 68 | $32,447 96 | $46,478 65 |
| Cost per million gallons pumped, . . . . . | $5.6750 | $4.6480 | $3.0300 | $3.4600 |
| Cost per million gallons raised 1 foot high, . . | .0473 | .0364 | .0233 | .0268 |

The daily average quantity pumped was 781,000 gallons less than the corresponding amount for the previous year.

No extensive repairs have been required on the machinery at this station. A new valve seat has been placed in the suction chamber on the intermediate pump on engine No. 3, to replace an old seat which had been cracked for several years. The plungers of this engine were also cleaned and repacked. The valve gear on engine No. 4 was repaired and adjusted and a new valve stem fitted on the high-pressure cylinder. The coal-hoisting winch has been moved from the small building at the rear of the station and set up in a corner of the boiler room. This change improves the appearance of the plant and decreases the cost of maintenance.

A Fairbanks railroad track scale of 100 tons capacity was installed in April in the side-track at the rear of the high-service station, and has been used since May 8 for weighing all coal received at both the high and low service stations. The scale platform is 40 feet long x 7½ feet wide, and the foundations and the side walls of the scale pit are all of Portland cement concrete. The total cost of installing the scale was $1,486.03. The cost of changes in the side-track made necessary by setting the scale, including necessary repairs, was $227.71.

*Chestnut Hill Low-service Station.*

The daily average quantity pumped at this station was 11.9 per cent. less, and the cost of operation was 9.7 per cent. less, than during the previous year, but the cost per million gallons pumped to the reservoir was $0.047 more than during the year 1908, for the reason that the reduction in the quantity pumped was greater than that in the cost of operation.

The following are the statistics relating to operations at this station: —

| | Engines Nos. 5, 6 and 7. |
|---|---|
| Total quantity pumped (gallons), | 19,183,420,000 |
| Daily average quantity pumped (gallons), | 52,557,000 |
| Total coal used (pounds), | 7,160,584 |
| Gallons pumped per pound of coal, | 2,679 |
| Average lift (feet), | 45.82 |
| Cost of pumping: — | |
| Labor, | $18,709 35 |
| Fuel, | 11,239 49 |
| Repairs, | 949 13 |
| Oil, waste and packing, | 619 28 |
| Small supplies, | 654 48 |
| Total for station, | $32,171 73 |
| Cost per million gallons pumped, | $1.6770 |
| Cost per million gallons raised 1 foot high, | .0366 |

The wire glass in the tops of the skylights in the engine and boiler rooms, which was badly cracked, has been replaced with rough plate glass ¼ of an inch in thickness, for the sum of $375. Glass of the same kind has been purchased to be used in replacing the glass in the vertical windows. The brick facing of the inner side of the roof parapet wall has been coated with antiaquatine, a colorless waterproofing liquid, for the purpose of preventing the spalling off of pieces of brick from the face of the wall. The interior of the equalizer tank was repainted by Sylvester Brothers for the sum of $135. The iron of the tank was thoroughly cleaned and then painted with a coat of red lead in boiled linseed oil and two coats of Gilsonite varnish.

## *Spot Pond Station.*

The following are statistics relating to operations at this station: —

| | |
|---|---|
| Total quantity pumped (gallons), | 2,693,510,000 |
| Daily average quantity pumped (gallons), | 7,380,000 |
| Total coal used (pounds), | 2,424,886 |
| Gallons pumped per pound of coal, | 1,111.00 |
| Average lift (feet), | 129.76 |
| Engine No. 8 operated (hours), | 319 |
| Engine No. 9 operated (hours), | 3,174 |
| Quantity pumped by Engine No. 8 (gallons), | 138,560,000 |
| Quantity pumped by Engine No. 9 (gallons), | 2,554,950,000 |
| Cost of pumping: — | |
| Labor, | $8,971 71 |
| Fuel, | 3,841 16 |
| Repairs, | 686 99 |
| Oil, waste and packing, | 235 03 |
| Small supplies, | 313 97 |
| Total for station, | $14,048 86 |
| Cost per million gallons pumped, | $5.2160 |
| Cost per million gallons raised 1 foot high, | .0402 |

The quantity of water pumped at this station shows a reduction of 11.4 per cent. as compared with the previous year, and was less than the amount pumped in any year since 1900. This was due to a large reduction in the use of water in Melrose, Medford, Winthrop and Swampscott, caused by the general introduction of meters during the past two years. The total cost of operating the station was slightly less than during the previous year, but the cost per million gallons pumped to the reservoir was $0.474 greater, due to a reduction in the quantity pumped without any reduction in the cost of labor.

## *Arlington Pumping Station.*

At this station was pumped all the water supplied to the town of Lexington, to the high-service district of the town of Arlington, and, after November 18, to a few houses in the town of Belmont.

The following are the statistics relating to operations at this station: —

| | |
|---|---|
| Total quantity pumped (gallons), | 241,310,000 |
| Daily average quantity pumped (gallons), | 661,000 |
| Total coal used (pounds), | 943,480 |
| Gallons pumped per pound of coal, | 255.76 |
| Average lift (feet), | 284 |
| Engine No. 10 operated (hours), | 6,405 |
| Engine No. 11 operated (hours), | 727 |
| Quantity pumped by Engine No. 10 (gallons), | 222,560,000 |
| Quantity pumped by Engine No. 11 (gallons), | 18,750,000 |

| Cost of pumping: — | |
|---|---|
| Labor, | $5,177 75 |
| Fuel, | 1,509 90 |
| Repairs, | 566 28 |
| Oil, waste and packing, | 110 97 |
| Small supplies, | 461 42 |
| Total for station, | $7,826 32 |

| | |
|---|---|
| Cost per million gallons pumped, | $32.4330 |
| Cost per million gallons raised 1 foot high, | .1142 |

There was a reduction of 13.8 per cent. in the quantity pumped and 14.4 per cent. in the cost of operation at this station as compared with the previous year.

Changes have been made in the jacket piping on the Allis-Chalmers engine and a feed-water heater has been placed in the flue between the boiler and the chimney, both of which have increased the efficiency of the plant.

During the month of March a Winslow recording gage was placed in the station for the purpose of indicating and recording electrically the elevation of the water in the standpipe on Arlington Heights.

### *West Roxbury Pumping Station.*

At this station water was pumped for supplying the higher portions of West Roxbury and Milton. The district in Milton was enlarged on October 22 by extending the higher service to about 70 water takers located on Canton Avenue, Highland, Reed and Spofford streets and Randolph Avenue.

The following are the statistics relating to operations at this station: —

Pumps operated 7,283 hours; average, 20 hours per day.

| | |
|---|---|
| Daily average quantity of water pumped (gallons) | 572,000 |
| Daily average quantity of coal consumed (pounds) | 2,001 |
| Gallons pumped per pound of coal | 286.05 |
| Average lift (feet) | 137 |

Cost of pumping: —

| | |
|---|---|
| Labor | $3,908 58 |
| Fuel | 2,009 27 |
| Repairs | 256 52 |
| Oil, waste and packing | 73 73 |
| Small supplies | 128 37 |
| Total for station | $6,376 47 |

| | |
|---|---|
| Cost per million gallons pumped | $30.5170 |
| Cost per million gallons raised 1 foot high | .2228 |

On account of the small storage capacity of the West Roxbury standpipe, the pumps in this station have at times during the past few years been taxed to their full capacity, and in order that there might be less danger of a failure of the supply the capacity of the station has been increased by the addition of a pumping engine and boiler. A compound duplex Knowles pumping engine of 1,750,000 gallons capacity, which was formerly used by the city of Melrose at Spot Pond, has been installed in a one-story addition, 9 feet 8 inches wide × 23 feet 4 inches long, which has been built on the west side of the pumping station, and a 60-inch diameter vertical boiler has been added to the boiler plant. The pump was thoroughly repaired and strengthened to adapt it to changed conditions, and the plungers were reduced from 12 inches to 11¾ inches in diameter and fitted with new sleeves. The boiler, furnished by the Hodge Boiler Works of East Boston, is 60 inches in diameter, having 7/16-inch steel shell, ½-inch tube sheets and contains 208 2-inch Spellerized steel tubes 7 feet 6 inches long. The boiler is fitted with a Gardner shaking grate. The work of repairing the engine, erecting the engine and boiler and doing the necessary piping both inside and outside the building was done by the maintenance force of the department. The cost of the work was $5,782.94, divided as follows: —

| | |
|---|---|
| Addition to building, | $1,720 00 |
| 60-inch vertical boiler, flue and grate, | 824 50 |
| Worthington surface condenser, | 505 00 |
| Refitting and strengthening pump, | 315 13 |
| New suction and discharge pipes and connections, | 510 82 |
| Teaming pump, | 60 00 |
| Labor, setting up engine and boiler, piping, grading, etc., | 1,150 03 |
| Steam and feed water piping, boiler and pipe covering, | 652 25 |
| Enlargement of shed, repairs and changes in fire room, | 45 21 |
| | $5,782 94 |

## Consumption of Water.

The daily average quantity of water consumed in the 18 municipalities supplied from the Metropolitan Water Works during the year 1909, as measured by meters, was 119,119,100 gallons, equal to 123 gallons per inhabitant in the district supplied. In addition to the above, 94,900 gallons daily were supplied to the United States Government reservation on Peddock's island, and 16,300 gallons daily to a small portion of the town of Saugus. The daily average quantity supplied to the Metropolitan Water District, as determined by pump measurement and by the flow in the Weston Aqueduct and the estimated yield of Spot Pond, was 119,386,000 gallons, equal to 123.7 gallons per inhabitant. The excess difference of 155,700 gallons per day between the quantity delivered by the aqueducts and that measured by meters to the several municipalities is due to differences in methods of measurement, to leakage from the Metropolitan Water Works reservoirs and pipes, and to the use of water at the Chestnut Hill and Spot Pond pumping stations.

The daily average consumption of water in each of the cities and towns supplied from the Metropolitan Works during the years 1908 and 1909, as measured by meters, was as follows: —

| | Estimated Population, 1909. | Daily Average Consumption. | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1908. | | 1909. | | Increase in Gallons. | Decrease in Gallons. |
| | | Gallons. | Gallons per Capita. | Gallons. | Gallons per Capita. | | |
| Boston, . . . | 632,960 | 98,379,300 | 158 | 94,029,900 | 149 | - | 4,349,400 |
| Somerville, . . . | 75,440 | 6,589,200 | 89 | 6,331,000 | 84 | - | 258,200 |
| Malden, . . . | 41,280 | 1,868,600 | 46 | 1,848,500 | 45 | - | 20,100 |
| Chelsea, . . . | 33,600 | 3,316,900 | 104 | 2,869,400 | 85 | - | 447,500 |
| Everett, . . . | 33,280 | 2,636,300 | 82 | 2,641,300 | 79 | 5,000 | - |
| Quincy, . . . | 31,440 | 3,003,600 | 99 | 2,919,000 | 93 | - | 84,600 |
| Medford, . . . | 21,890 | 2,069,000 | 97 | 1,732,300 | 79 | - | 336,700 |
| Melrose, . . . | 15,350 | 1,351,900 | 89 | 962,300 | 63 | - | 389,600 |
| Revere, . . . | 14,830 | 1,276,300 | 89 | 1,250,700 | 84 | - | 25,600 |
| Watertown, . . | 12,630 | 732,000 | 60 | 755,300 | 60 | 23,300 | - |
| Arlington, . . . | 10,700 | 971,200 | 93 | 861,300 | 81 | - | 109,900 |
| Milton, . . . | 7,800 | 331,600 | 44 | 313,200 | 40 | - | 18.400 |
| Winthrop, . . . | 9,140 | 928,700 | 118 | 877,600 | 96 | - | 51,100 |
| Stoneham, . . . | 6,750 | 626,000 | 94 | 575,200 | 85 | - | 50,800 |
| Belmont, . . . | 5,000 | 365,400 | 78 | 310,100 | 62 | - | 55,300 |
| Lexington, . . . | 4,870 | 328,800 | 71 | 329,400 | 68 | 600 | - |
| Nahant, . . . | 1,860 | 140,100 | 75 | 124,400 | 67 | - | 15,700 |
| Swampscott, . . | 6,670 | 509,300 | 78 | 388,200 | 58 | - | 121,100 |
| District, . . | 965,490 | 125,424,200 | 133 | 119,119,100 | 123 | - | 6,305,100 |

The consumption in the several districts was as follows: —

| | Gallons per Day. | Decrease (Gallons per Day). | Percentage of Decrease. |
|---|---|---|---|
| Southern low-service district, embracing the low-service district of Boston, with the exception of Charlestown and East Boston, . | 48,335,600 | 2,978,000 | 5.80 |
| Northern low-service district, embracing the low-service districts of Somerville, Chelsea, Malden, Medford, Everett, Arlington, Charlestown and East Boston, . . . . . . . . | 26,531,500 | 2,043,200 | 7.15 |
| Southern high-service district, embracing the high-service districts of Boston, Quincy, Watertown, Belmont, and a portion of Milton, | 35,629,400 | 174,700 | 0.49 |
| Northern high-service district, embracing Melrose, Revere, Winthrop, Swampscott, Nahant and Stoneham, and the high-service districts of Somerville, Chelsea, Malden, Medford, Everett and East Boston, . . . . . . . . . . . . . | 7,393,800 | 936,800 | 11.25 |
| Southern extra high-service district, embracing the higher portions of West Roxbury and Milton, . . . . . . . . | 572,500 | 67,100 | 10.49 |
| Northern extra high-service district, embracing Lexington and the higher portions of Arlington, . . . . . . . . | 656,300 | 105,300 | 13.83 |
| Totals, . . . . . . . . . . . . . | 119,119,100 | 6,305,100 | 5.03 |

With the exception of the city of Everett and the towns of Watertown and Lexington, every municipality in the Metropolitan District used less water in 1909 than in 1908, and in all except Watertown the per capita use was less. The daily average use in the whole District was 6,305,100 gallons, or 5.03 per cent. less than during the preceding year, and the per capita use was less than in any year since 1903.

During January the daily average consumption was 2,049,100 gallons more than during the corresponding month in 1908, while in February there was a reduction of 13,900,500 gallons per day as compared with the corresponding month during the previous year. This was largely due to the fact that the average temperature for the month was 31.6 degrees, as compared with 25.7 degrees in February, 1908, and illustrates very forcibly the use or waste of water to prevent freezing. During every month with the exception of January the consumption was less than during the previous year, and for the last seven months of the year the average reduction was 7,700,000 gallons per day. The reduction in the quantity used is due in great measure to the increased use of water meters, and to other measures taken to prevent the waste of water. The absence of long-continued cold weather during the winter, or hot, dry weather during the summer, and the use of oil in place of water for street sprinkling, have also been contributing causes.

The effect of the general introduction of meters upon the use of water is illustrated by the reduction which has been effected during the past few years by the introduction of meters in Medford, Melrose, Swampscott and Winthrop.

| | PER CAPITA CONSUMPTION (GALLONS). | | | REDUCTION IN TWO YEARS. | | PER CENT. OF SERVICES METERED. | |
|---|---|---|---|---|---|---|---|
| | 1907. | 1908. | 1909. | Gallons per Capita. | Per Cent. | January, 1907. | January, 1910. |
| **Medford,** | 105 | 97 | 79 | 26 | 24.8 | 10.4 | 56.1 |
| **Melrose,** | 118 | 89 | 63 | 55 | 46.7 | 3.9 | 100.0 |
| **Swampscott,** | 74 | 78 | 58 | 16 | 21.6 | – | 97.1 |
| **Winthrop,** | 117 | 118 | 96 | 21 | 17.9 | 2.3 | 66.1 |

In Melrose the metering of services was practically finished in 1908, while in Winthrop but comparatively few meters were set until the *past year.*

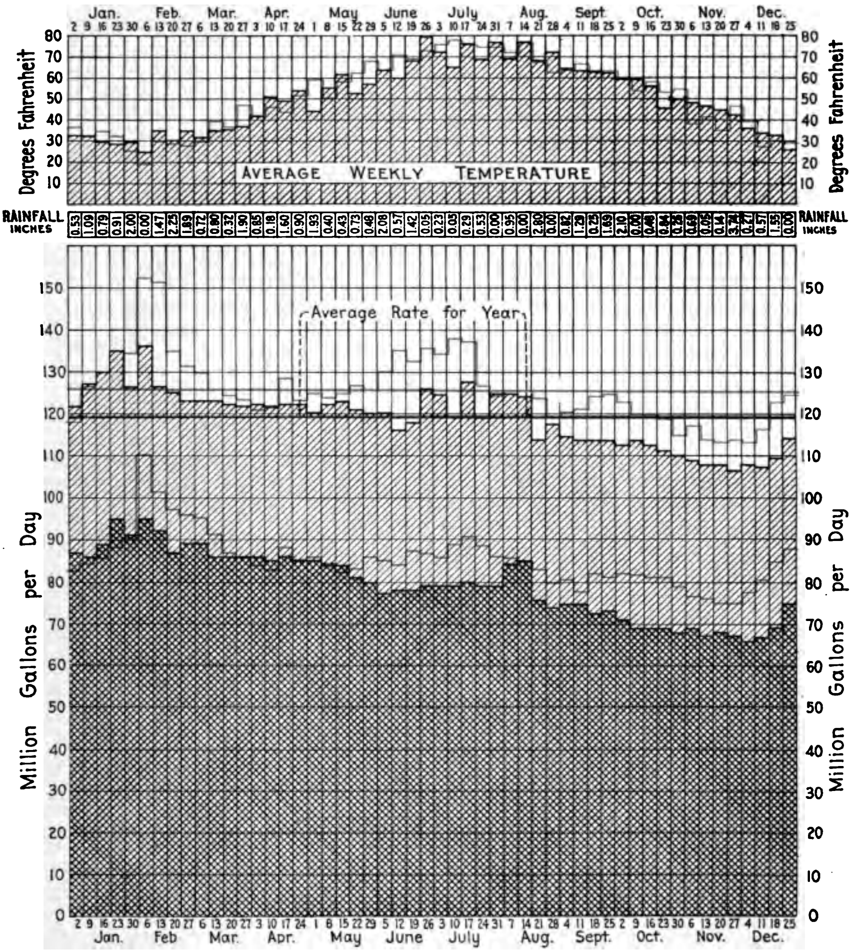
The diagram facing this page shows graphically the average daily consumption and the rate of consumption between the hours of 1 and 4 A.M. in the District supplied by the Metropolitan Works for each week during the years 1908 and 1909. The amount of rainfall and the average temperature for each week, as observed at the Chestnut Hill Reservoir, are also shown. It will be noted that the weeks of highest consumption correspond with the weeks of low temperature during the winter and of high temperature and low rainfall during the summer. A rainfall of 2.8 inches during the week ending August 21 resulted in a reduction of about 9,000,000 gallons in the daily average consumption of water during the following week. The diagram also shows graphically that the reduction in the night rate was substantially the same as the reduction during the whole twenty-four hours. The high night rates during the weeks ending August 7 and 14 were due to allowing hand hose and lawn sprinklers to run continuously throughout the night during a hot and dry period.

### *Metering of Service Pipes.*

Chapter 424 of the Acts of the year 1907 provides that after December 31, 1907, all cities and towns which derive their water from the Metropolitan Works shall equip all new service pipes with water meters, and shall also annually equip with meters 5 per cent. of the services which were unmetered on that date. During the past year all cities and towns in the District, with the exception of Quincy, have set meters on not less than 5 per cent. of the number of service pipes which were unmetered on December 31, 1907, and have also metered all new services where the premises to be supplied have been occupied. The city of Boston did not comply with the requirements of the Act in the year 1908. Only 98 meters were set on 1,177 new service pipes installed in Boston during that year, and the number of meters set on old services during the two years is 3,289 less than the 10 per cent. required by the Act. With these two exceptions all cities and towns in the District have set during the past two years meters on not less than 10 per cent. of the services in use on December 31, 1907, and have set meters on all new services connected with premises which have been occupied.

The following table gives the statistics relative to the setting of meters and the number of service pipes and meters connected with the distributing pipes in the District on December 31, 1909: —

# AVERAGE RATE OF CONSUMPTION
IN
# METROPOLITAN WATER DISTRICT
AND
## RAINFALL AND AVERAGE TEMPERATURE OF AIR AT CHESTNUT HILL RESERVOIR
FOR
## EACH WEEK DURING 1909



Average Rate of Consumption for each week, thus ................................ ▨

" " " " " between 1 and 4 A.M. for each week, thus ......... ▩

Averages in 1908 shown in Red.

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FOUNDATIONS.

| CITY OR TOWN. | Number of Meters required to be set on Old Services Each Year. | METERS SET ON OLD SERVICES. | | New Services installed, 1909.[1] | New Services equipped with Meters, 1909.[1] | Services in Use December 31, 1909. | Meters in use December 31, 1909. | Per Cent. of Services metered December 31, 1909. |
|---|---|---|---|---|---|---|---|---|
| | | 1908. | 1909. | | | | | |
| Boston, . . | 4,438 | 84 | 5,503 | 1,151 | 1,081 | 96,132 | 11,690 | 12.16 |
| Somerville, . . | 411 | 732 | 621 | 211 | 201 | 12,018 | 5,147 | 42.83 |
| Malden, . . | 14 | 43 | 62 | 171 | 85 | 7,303 | 6,978 | 95.55 |
| Chelsea, . . | 240 | 198 | 756 | 99 | 91 | 6,613 | 2,212 | 33.45 |
| Everett, . . | 252 | 338 | 255 | 81 | 84 | 5,320 | 843 | 15.85 |
| Quincy, . . | 230 | 358 | 33 | 365 | 61 | 6,814 | 2,032 | 29.82 |
| Medford, . . | 179 | 857 | 927 | 108 | 110 | 4,624 | 2,594 | 56.10 |
| Melrose, . . | 119 | 2,432 | 135 | 43 | 59 | 3,510 | 3,510 | 100.00 |
| Revere, . . | 138 | 85 | 184 | 193 | 114 | 3,214 | 590 | 18.36 |
| Watertown, . . | – | – | – | 54 | 54 | 1,973 | 1,973 | 100.00 |
| Arlington, . . | 55 | 108 | 56 | 56 | 73 | 2,032 | 1,121 | 55.16 |
| Milton, . . . | – | – | – | 52 | 52 | 1,380 | 1,380 | 100.00 |
| Winthrop, . . | 100 | 213 | 975 | 103 | 151 | 2,320 | 1,533 | 66.08 |
| Stoneham, . . | 65 | 116 | 225 | 31 | 31 | 1,447 | 430 | 29.72 |
| Belmont, . . | – | – | – | 48 | 48 | 883 | 883 | 100.00 |
| Lexington, . . | 32 | 113 | 70 | 42 | 47 | 780 | 362 | 46.41 |
| Nahant, . . | 16 | 30 | 40 | 8 | 8 | 398 | 179 | 44.98 |
| Swampscott, . . | 21 | 264 | 142 | 47 | 47 | 1,439 | 1,398 | 97.15 |
| Totals, . . | 6,310 | 5,971 | 9,984 | 2,863 | 2,397 | 158,200 | 44,855 | 28.35 |

---

[1] The number of new meters installed and the number of new services equipped with meters seldom agree exactly for the reason that service pipes are installed but meters are not set until the buildings are permanently occupied.

At the end of the year 28.35 per cent. of all the service pipes in the District were metered, as compared with 21.5 per cent. at the beginning of the year. In 6 municipalities all of the services are now metered, and, excluding Boston, 53.4 per cent. of the services were metered at the end of the year.

## QUALITY OF THE WATER.

About 5.7 per cent. of the water used in the Metropolitan District was drawn from Lake Cochituate, 2 per cent. from Framingham Reservoir No. 2, 67.7 per cent. from Framingham Reservoir No. 3 and 24.6 per cent. from the Sudbury Reservoir. Nearly 90 per cent.

of the water drawn from the Sudbury and Framingham No. 3 reservoirs was supplied to those reservoirs from the Wachusett Reservoir through the Wachusett Aqueduct.

Early in the year a growth of the microscopic diatom Asterionella developed in the Wachusett Reservoir. The numbers of the organism gradually increased, and as the water from the Wachusett Reservoir was delivered into the Sudbury and Framingham No. 3 reservoirs growths of the organism appeared in those reservoirs, and early in March were present in the water delivered to the consumers in sufficient numbers to cause complaints of a geranium taste and odor. At this time the number of the organism in each cubic centimeter of water was about 10,000. During March and April and until the middle of May the organism continued to increase in numbers, the maximum number in the Wachusett and Sudbury reservoirs being about 27,500 per cubic centimeter, and in the water drawn from the taps about 25,000. From the first of April until the middle of June the water drawn from the taps, with the exception of that supplied from Spot Pond to the northern high-service district, had a very disagreeable taste and odor.

Although this organism is generally present in all of our reservoirs in small numbers, it has never previously appeared in sufficient numbers to cause any noticeable taste and odor, and it has seldom caused trouble elsewhere, except in places where ground waters have been stored in open reservoirs or tanks and exposed to the light. Under these conditions the organism develops in large numbers, and it has been found necessary to cover reservoirs in which water is stored which has been taken from wells or filter-galleries.

The growth of Asterionella in the Wachusett Reservoir during the past year has been exceptional in that so large a number should grow in a surface water, and also in that the organism continued to increase in numbers through the winter. After July 1 the water delivered to the District was unobjectionable for the remainder of the year.

Samples of the water have been collected monthly from 24 points and semimonthly from 5 points on the works, and sent to the State Board of Health for chemical analysis. Samples of water have also been collected weekly at 35 points and biweekly at 8 points, and examined microscopically and for color, odor, taste and turbidity in the biological laboratory of the Metropolitan Water and Sewerage Board.

The following table gives a comparison of the average results of the examinations of water from a tap in Boston for the years 1901 to 1909, inclusive: —

| | 1901. | 1902. | 1903. | 1904. | 1905. | 1906. | 1907. | 1908. | 1909. |
|---|---|---|---|---|---|---|---|---|---|
| *State Board of Health Examinations.* | | | | | | | | | |
| Color (Nessler standard), | 0.24 | 0.26 | 0.25 | 0.23[1] | 0.24[1] | 0.24[1] | 0.22[1] | 0.19[1] | 0.18[1] |
| Total residue, | 4.43 | 3.93 | 3.98 | 3.93 | 3.86 | 3.86 | 3.83 | 3.50 | 3.46 |
| Loss on ignition, | 1.64 | 1.56 | 1.50 | 1.59 | 1.59 | 1.39 | 1.40 | 1.35 | 1.43 |
| Free ammonia, | 0.0013 | 0.0016 | 0.0013 | 0.0023 | 0.0020 | 0.0018 | 0.0013 | 0.0011 | 0.0011 |
| Albuminoid ammonia, total, | 0.0158 | 0.0139 | 0.0125 | 0.0139 | 0.0145 | 0.0159 | 0.0129 | 0.0115 | 0.0128 |
| Albuminoid ammonia, dissolved, | 0.0143 | 0.0119 | 0.0110 | 0.0121 | 0.0124 | 0.0134 | 0.0109 | 0.0092 | 0.0103 |
| Albuminoid ammonia, suspended, | 0.0015 | 0.0020 | 0.0015 | 0.0018 | 0.0021 | 0.0025 | 0.0020 | 0.0024 | 0.0025 |
| Chlorine, | 0.30 | 0.29 | 0.30 | 0.34 | 0.35 | 0.34 | 0.33 | 0.33 | 0.28 |
| Nitrogen as nitrates, | 0.0173 | 0.0092 | 0.0142 | 0.0110 | 0.0083 | 0.0054 | 0.0068 | 0.0092 | 0.0034 |
| Nitrogen as nitrites, | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0000 |
| Oxygen consumed, | 0.42 | 0.40 | 0.39 | 0.37 | 0.35 | 0.36 | 0.32 | 0.26 | 0.25 |
| Hardness, | 1.7 | 1.3 | 1.5 | 1.5 | 1.4 | 1.3 | 1.3 | 1.2 | 1.3 |
| *Metropolitan Water and Sewerage Board Examinations.* | | | | | | | | | |
| Color (platinum standard), | 34 | 33 | 35 | 32 | 28 | 25 | 27 | 22 | 23 |
| Turbidity, | 2.0 | 2.3 | 2.2 | 2.4 | 1.9 | 2.2 | 2.2 | 2.4 | 2.6 |
| Total organisms, | 243 | 367 | 286 | 303 | 528 | 550 | 427 | 695 | 1,959 |
| Amorphous matter, | 38 | 34 | 36 | 36 | 37 | 42 | 47 | 64 | 97 |
| Bacteria, | 162 | 164 | 126 | 176 | 231 | 154 | 176 | 148 | 195 |

NOTE. — Chemical analyses are in parts per 100,000, organisms and amorphous matter in standard units per cubic centimeter, and bacteria in number per cubic centimeter. The standard unit has an area of 400 square microns, and by its use the number of diatomaceæ are decreased, and the number of chlorophyceæ and cyanophyceæ are very much increased, as compared with the number of organisms.

[1] Platinum standard.

In the biological laboratory there have been made 2,471 microscopical and 1,072 bacterial examinations of water collected at various points upon the works. Of the microscopical examinations 1,953 were of the regular weekly and biweekly samples and 518 were special examinations.

The bacteriological work consisted of routine weekly examinations of the main feeders of the Sudbury Reservoir, of Framingham Reservoir No. 3 and of Lake Cochituate, and monthly tests of the efficiency of the Pegan Brook, Marlborough Brook and Sterling filter-beds. Special work was done in connection with the growth of Asterionella, including determinations of the amount of dissolved oxygen and carbon dioxide in the different reservoirs.

The water of the Wachusett Reservoir, as has been previously stated, contained a very large growth of Asterionella during the early part of the year, continuing until about the middle of June.

During October there was a small growth of Synura at the upper end of the reservoir, but the water as drawn from the reservoir at the dam during the last six months of the year was of excellent quality and low in color.

As over 90 per cent. of the water drawn from the Sudbury and Framingham No. 3 reservoirs was received from the Wachusett Reservoir the organisms in all of these reservoirs were generally similar in species and of equal numbers. In the Marlborough arm of the Sudbury Reservoir a growth of Dinobryon was present from October until the end of the year. The water at the dam contained a maximum of 1,043 units on November 9, and the organism caused the water to have an objectionable odor for about seven weeks.

At the Whitehall Reservoir there was a growth of Synura for two or three weeks in February, the maximum number observed being 1,230, on February 8. The color of the water ranged from 82 to 64.

The number of organisms in the Hopkinton and Ashland reservoirs was small and their character unobjectionable. The color of the water at the Hopkinton Reservoir ranged from 86 to 48 and at the Ashland Reservoir from 92 to 54. In September there were indications of stagnation in the water at the bottom of the Ashland Reservoir, the color at the surface being 60 and at the bottom 92. The dissolved oxygen in the water at the bottom of the reservoir at this time was but 1.9 per cent. of saturation.

In Framingham Reservoir No. 2 there were no growths of organisms to cause disagreeable tastes or odors. The observed color varied from 120 to 46.

At Lake Cochituate Chlamydomonas was present in the water in sufficient numbers to make the water objectionable for drinking purposes from the beginning of the year until June 1, and from September 20 to the end of the year. Dinobryon was also present in the water in November. There were 660 units per cubic centimeter of Uroglena in the water at the southerly end of the lake in March, and 500 units in June, but none was observed at the northerly end of the lake, from which the water is taken. A growth of Asterionella developed in November and December, reaching a maximum of 3,040 units on December 6. The color of the surface samples ranged during the year from 35 to 20.

In the Weston Reservoir Asterionella was present during the early part of the year and until June, with a maximum of 11,000 units on May 11, and Dinobryon was present in November and December, with a maximum of 1,330 units on November 9. In both cases the growths occurred at the same time as similar growths in the Sudbury Reservoir, from which the Weston Reservoir is supplied.

The principal organisms in the Waban Hill Reservoir were Asterionella from January until June, with a maximum of 9,700 units early in May; Uroglena, which caused a disagreeable odor, in the latter part of May; and Dinobryon, which gave the water a fishy odor, during the latter part of November.

The water in Spot Pond contained Asterionella during the early part of the year, but the numbers present were not large enough to give an objectionable taste to the water, except for six weeks in April and May. Uroglena was present in small numbers, but only once, on June 7, in sufficient numbers to give a noticeable odor to the water. Dinobryon was present in small numbers from October to the end of the year. The average color of the water was 16.

The waters of the Fells and Bear Hill reservoirs contained the same organisms, in substantially the same numbers, as Spot Pond.

Uroglena was present in the Forbes Hill Reservoir with 5,200 units in April, and again in December with 4,630 units, and in the Mystic Reservoir during the first five months of the year.

The growth of Asterionella was so general in all of the reservoirs from which it was necessary to draw the supply of the District that the water drawn from the taps in all portions of the Metropolitan District, with the exception of the northern high-service district, which is supplied from Spot Pond, had an objectionable taste and odor from about March 1 to July 1. Other objectionable growths were prevented from reaching the consumers by isolating the reservoirs while the waters were not suitable for use.

In August complaints were received from a small district in Milton of the presence of organisms of considerable size in the water as drawn from the taps. The organisms proved to be Planaria Maculata, a flat worm, and Acellus Aquaticus, belonging among the crustacea. As they could not be found elsewhere, it is supposed that they were breeding in the local distributing pipes.

In Appendix No. 4, tables Nos. 26 to 32, are given the results of

During October there was a small growth of Synura at the upper end of the reservoir, but the water as drawn from the reservoir at the dam during the last six months of the year was of excellent quality and low in color.

As over 90 per cent. of the water drawn from the Sudbury and Framingham No. 3 reservoirs was received from the Wachusett Reservoir the organisms in all of these reservoirs were generally similar in species and of equal numbers. In the Marlborough arm of the Sudbury Reservoir a growth of Dinobryon was present from October until the end of the year. The water at the dam contained a maximum of 1,048 units on November 9, and the organism caused the water to have an objectionable odor for about seven weeks.

At the Whitehall Reservoir there was a growth of Synura for two or three weeks in February, the maximum number observed being [illegible] on February 8. The color of the water ranged from 52 to 64.

The number of organisms in the Hopkinton and Ashland reservoirs was small and their character unobjectionable. The color of the water in the Hopkinton Reservoir ranged from [illegible] to 45 and at the Ashland Reservoir from [illegible] to [illegible]. In September there were indications of stagnation in the water at the bottom of the Ashland Reservoir, the color at the surface being 81 and at the bottom 92. The dissolved oxygen in the water at the bottom of the reservoir at this time was but [illegible] per cent. of saturation.

In Framingham Reservoir No. 2 there were no growths of organisms to cause disagreeable tastes or odors. The [illegible] chemical examinations of the water made by the State Board of Health, and in tables Nos. 33 and 34 the average number of organisms and bacteria in the water during each of the past twelve years.

### SANITARY INSPECTION.

A force varying from 3 to 15 men has been employed to patrol the several reservoirs for the purpose of detecting any violations of the regulations of the Board relative to boating, fishing, hunting and polluting the water or injuring the property of the Commonwealth.

On the Wachusett watershed 9 cases of typhoid fever and 1 of dysentery were reported, all from the town of Holden, and with the exception of 2 cases, which occurred at the Mount Pleasant Hotel, all cases occurred in houses not supplied with water from a public water supply. An epidemic of typhoid fever originated among the 600 guests at the Mount Pleasant House, in Holden, on Labor Day, September 6, which is reported to have resulted in 59 cases and 8 deaths. With 2 exceptions these cases developed outside the watershed. Investigation by the State Board of Health showed that the epidemic was caused by the contamination of the milk used at the hotel by a waitress who was suffering from the disease in a mild form.

On the Sudbury and Cochituate watersheds 5 cases of typhoid fever were reported from Marlborough, 5 from Westborough, 2 from Ashland, 6 from South Framingham and 1 from Natick, making a total of 19, as compared with 24 during the year 1908. In 9 of these cases the patients resided in houses connected with the public sewers, which discharge outside the watershed. In all cases precautions were taken to protect the water supply from danger of pollution.

The sanitary conditions on the Wachusett watershed have been improved by the removal of 5 buildings, 4 of which were on property belonging to the Board, and by the construction of 7 cesspools. Twenty new buildings were built on the watershed during the year, 16 of which were provided with cesspools to receive the drainage. The Dawson and Woods mills at Holden have not been operated during the past year, and as a result the number of persons residing in the tenements on the mill properties was 124 less than during the previous year. On the other hand, a larger force has been employed in the mills at Jeffersonville, and the population in the mill tenements at this point has increased from 151 to 228.

On the Sudbury watershed 44 old and 14 new premises were connected with the public sewers, which convey the drainage outside the watershed. Mr. Waldo Fay constructed on the grounds of his private school in Southborough a cesspool 5 feet x 6 feet x 125 feet in length, to receive and care for the overflow from the old cesspool, which had failed to care for the drainage from the school buildings.

On the Cochituate watershed 33 old and 29 new premises were connected with the public sewers.

In the four places on the Sudbury and Cochituate watersheds which have systems of sewerage conveying the drainage outside the watersheds, there were on December 31, 1909, 3,722 premises connected with the sewers and 169 premises not yet connected on streets where there are existing sewers, as follows: —

| | Premises connected with Sewers. | Premises not connected with Sewers. |
|---|---|---|
| **Marlborough,** | 1,534 | 76 |
| **Westborough,** | 500 | 30 |
| **Framingham,** | 1,064 | 21 |
| **Natick,** | 624 | 42 |
| **Totals,** | 3,722 | 169 |

During the year a number of persons were apprehended in violation of the regulations of the Board. Forty-eight persons were apprehended for violations of fishing regulations. Eleven of these were summoned into court and 6 of them were fined. Sixteen men and boys were discovered bathing in the reservoirs. Five of these were summoned into court and 2 were fined.

The cutting of ice at Framingham reservoirs Nos. 2 and 3, the Sudbury and Whitehall reservoirs, and Dudley and Waushacum ponds has been inspected to see that the work was done in such a way as not to pollute the water supply.

A summary of the work of sanitary inspection for the year 1909 is given in the following tables. The first table shows for the Wachusett watershed the number of premises inspected, the classification of cases inspected and the condition of the premises at the end of the year; the second table gives the corresponding information for the Sudbury and Cochituate watersheds.

The headings of these tables are easily understood, except in a few instances: under the heading "Premises Vacant" are included all cases which at present furnish no objectionable drainage, but which might furnish such drainage if the premises were occupied; under the heading "Unsatisfactory" are included all cases where it is possible that under the most unfavorable conditions drainage from privies or sinks may reach a water course, all suspected cases and all cases of manufacturing wastes entering feeders, even though there may have been some attempt at previous purification. This class is about 3½ per cent. of the total number of premises.

### *Summary of Sanitary Inspections on the Wachusett Watershed in 1909.*

| DISTRICT. | Number of Premises inspected.[1] | Classification of Cases inspected. | | | | | | | | | | | | | Condition at End of Year. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Cesspools dug before 1909. | Cesspools dug in 1909. | Direct Privy Drainage. | Indirect Privy Drainage. | Direct Sink Drainage. | Indirect Sink Drainage. | | Barn Drainage. | | Manufacturing Wastes. | Premises Vacant. | No Drainage. | Drainage carried to Filter-beds. | | |
| | | | | | | | Satisfactory. | Unsatisfactory. | Satisfactory. | Unsatisfactory. | | | | | Satisfactory. | Unsatisfactory. |
| French Brook, | 60 | 30 | – | – | – | – | 22 | 2 | 42 | 1 | – | 2 | 4 | – | 57 | 3 |
| Muddy Brook, | 32 | 11 | – | – | – | – | 19 | – | 27 | – | – | – | 1 | 1 | 32 | – |
| Gates Brook, | 143 | 98 | 2 | – | – | – | 30 | 1 | 72 | – | – | 7 | 5 | – | 142 | 1 |
| Malden Brook, | 18 | 9 | 1 | – | – | – | 6 | – | 14 | – | – | 1 | 1 | – | 18 | – |
| Chaffin Brook, | 170 | 81 | 4 | – | 1 | – | 59 | 9 | 108 | – | – | 11 | 6 | – | 161 | 9 |
| Asnebumskit Brook, | 285 | 159 | 9 | 3 | 8 | 22 | 48 | 10 | 117 | – | 3 | 21 | 21 | 2 | 250 | 35 |
| Muschopauge, | 95 | 28 | – | – | 2 | 3 | 43 | 3 | 57 | 2 | – | 13 | 5 | – | 88 | 7 |
| South Wachusett Brook, | 84 | 23 | 1 | 1 | 2 | 1 | 40 | 5 | 56 | 2 | – | 7 | 7 | – | 76 | 8 |
| Trout Brook, | 37 | 4 | – | – | – | – | 24 | 1 | 33 | – | 1 | 4 | 3 | – | 35 | 2 |
| East Wachusett Brook, | 211 | 63 | 4 | 2 | 3 | 4 | 99 | 9 | 146 | 4 | – | 11 | 18 | 1 | 194 | 17 |
| Stillwater River, | 146 | 50 | – | – | 1 | – | 77 | 3 | 93 | 3 | – | 5 | 10 | 1 | 142 | 4 |
| Waushacum, | 166[2] | 50 | 4 | – | 1 | 1 | 83 | 4 | 87 | 2 | – | 9 | 15 | 87 | 161 | 5 |
| French Hill, | 28 | 19 | – | – | – | – | 6 | – | 16 | – | – | 3 | – | – | 28 | – |
| Totals, | 1,475 | 625 | 25 | 6 | 18 | 31 | 556 | 47 | 868 | 14 | 4 | 94 | 96 | 92 | 1,384 | 91 |

[1] On some premises there are 2 or more cases.

[2] Not including 205 summer cottages located near the Waushacum Lakes.

## Summary of Sanitary Inspections on the Sudbury and Cochituate Watersheds in [illegible]

| DISTRICT. | Number of Premises inspected.¹ | Sewer Connections. | Cesspools dug before 1900. | Cesspools dug in 1900. | Direct Privy Drainage. | Indirect Privy Drainage. | Direct Sink Drainage. | [illegible] Satisfactory. | [illegible] Unsatisfactory. | [illegible] Satisfactory. | [illegible] Unsatisfactory. | Manufacturing Wastes. | Premises Vacant. | No Drainage. | Drainage connected to [illegible] | Condition at End of Year. Satisfactory. | Condition at End of Year. Unsatisfactory. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Sudbury Watershed.* | | | | | | | | | | | | | | | | | |
| Farm Pond, | 959 | 337 | 9 | 1 | - | | - | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | | [illegible] | [illegible] |
| Framingham Reservoir No. 3, | 79 | - | 86 | [illegible] | | | | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | | [illegible] | [illegible] |
| Stony Brook, | 201 | - | 213 | [illegible] | | | 2 | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | | [illegible] | [illegible] |
| Angle Brook, | 1,004 | 1,534 | 277 | 1 | - | 3 | | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Framingham Reservoirs Nos. 1 and 2, and Cold Spring Brook, | 267 | - | 105 | | | 2 | | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | | [illegible] | [illegible] |
| Eastern Sudbury, | 239 | - | 210 | 8 | | 3 | 1 | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | | [illegible] | [illegible] |
| Indian Brook, | 415 | - | 171 | - | | 2 | 7 | [illegible] | [illegible] | [illegible] | [illegible] | 1 | [illegible] | [illegible] | | [illegible] | [illegible] |
| Western Sudbury, | 188 | - | 64 | - | | 3 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | | [illegible] | [illegible] |
| Whitehall Reservoir, | 111 | - | 29 | 1 | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | | [illegible] | [illegible] |
| Cedar Swamp, | 804 | 500 | 162 | - | - | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | [illegible] | [illegible] | | [illegible] | [illegible] |
| *Cochituate Watershed.* | | | | | | | | | | | | | | | | | |
| Snake Brook, | 818 | - | 222 | 8 | - | - | 8 | [illegible] | [illegible] | [illegible] | 1 | | [illegible] | [illegible] | | [illegible] | [illegible] |
| Pegan Brook, | 939 | 621 | 208 | | - | | | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | 443 | [illegible] | [illegible] |
| Course Brook, | 88 | 1 | 40 | 1 | - | | | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] | | [illegible] | [illegible] |
| Beaver Dam Brook, | 1,117 | 820 | 131 | 9 | - | 1 | 2 | [illegible] | [illegible] | [illegible] | [illegible] | 3 | [illegible] | [illegible] | | [illegible] | [illegible] |
| Totals, | 7,088 | 3,792 | 1,096 | 27 | | 14 | 25 | [illegible] | 140 | 1,844 | [illegible] | 3 | 455 | 140 | 2,723 | [illegible] | [illegible] |

¹ On some premises there are 2 or more cases.

## Swamp Ditches and Brooks.

The drainage ditches in swamps on the several watersheds, aggregating 36.36 miles in length, have been cleaned, and the weeds and brush mowed and burned for a width of 10 to 20 feet on either side of the ditches. Four wooden dams or bulkheads forming two settling basins at the outlet of the ditches leading from Crane Swamp and a small swamp about 300 feet below the upper dam into the open channel of the Wachusett Aqueduct have been replaced by concrete bulkheads 8 inches thick, provided with grooves for stop-planks to control the elevation of the water. A new settling basin has been constructed to prevent the washing of sand into the open channel from a small brook entering from the north about 600 feet below the terminal chamber. The cost of these bulkheads was $393.92. Four bridges over ditches on the Sears estate in Southborough discharging into the open channel, and two over Broad Meadow Brook and two over Angelico Brook discharging into the Sudbury Reservoir, have been re-covered with 2-inch chestnut plank.

Observations of the colors of waters from swamps have been made monthly and the results tabulated as follows: —

| SWAMP. | Area of Watershed (Acres). | Area of Swamp (Acres). | Length of Ditches (Feet). | Colors of Waters (Platinum Standard). | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | BEFORE DRAINING. | | AFTER DRAINING. | | |
| | | | | Averages for Years 1894, 1895, 1899. | Averages for Years 1900, 1901, 1902. | 1907. | 1908. | 1909. |
| Crane, . . . | 1,856 | 460 | 45,250 | 195 | - | 77 | 72 | 64 |
| No. 54, . . . | 750 | 72 | 8,930 | - | 90 | 53 | 41 | 33 |
| No. 55, . . . | 1,625 | 220 | 27,661 | - | 127 | 80[1] | 44 | 36 |
| No. 76, . . . | 225 | 26 | 6,173 | - | 44 | 27 | 24 | 20 |

[1] Nearly one-half of the ditches in swamp 55 were not built until 1907.

## Protection of Supply.

In addition to the work of sanitary inspection and the care of the swamp ditches, which are described elsewhere in this report, the work of protecting the supply has included the maintenance and operation of filter-beds for the purpose of purifying surface water from thickly populated districts before its admission to the storage reservoirs. The Marlborough Brook filter-beds, with an area of

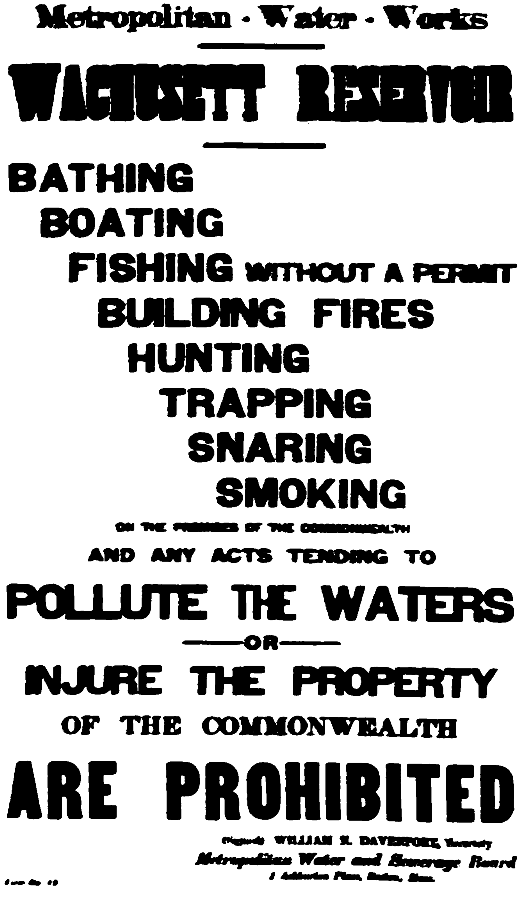
14 acres, filter the water from about 1.8 square miles in the thickly settled portion of the city of Marlborough before its admission to the Sudbury Reservoir. These beds were cleaned in June and weeded in September and October. With the exception of a small quantity of water which overflowed into the reservoir on February 20, the entire discharge of the brook was filtered. During 1 day in February, 3 days in March, 3 days in April and 2 days in May there was a small flow of diluted sewage into the filter-bed near Farm Road, which receives the overflow from the Marlborough main sewer during freshets, and there was a flow of ground water into the bed at times during February, March, April and May.

The surface drainage from an area of about 1 square mile in the thickly settled portion of Natick is collected in a basin and then pumped on to filter-beds before entering Lake Cochituate. The pumps were operated on 174 days during the year. A small quantity of unfiltered water overflowed into the lake from the basin on Pegan Brook on February 20, and small quantities were wasted from the intercepting ditch into the lake on February 10, 20 and 24. The total quantity pumped was 251,598,000 gallons, equivalent to a daily average of 689,310 gallons. Of the total, 174,605,000 gallons were from Pegan Brook and 76,993,000 gallons from the intercepting ditch which collects water from the brooks formerly draining into Pegan Brook Meadow. The total quantity of coal consumed was 150,094 pounds, and 1,676 gallons of water were pumped per pound of coal. The cost of operating the station, cleaning the filter-beds and caring for the grounds was $2,606.47, making the cost per million gallons treated $10.36. The filter-beds were cleaned several times during the year and the ditches in the receiving reservoir were cleaned once. The interior wood and iron work and the exterior woodwork of the pumping station were painted.

The Sterling filter-beds, having an area of 2 acres, receive water from the brook draining about 225 acres in the village of Sterling. The beds were in continuous operation during the year. On the morning of March 25 a heavy rain occurred which filled all four of the beds with water. At this time two small slides occurred in the southwesterly corner of the embankment of bed No. 3, the larger slide being about 30 feet long x 15 feet wide, and the smaller one about 10 feet long x 8 feet wide. These slides consisted of the slipping off of the outside face of the embankment for a thickness of about 12 inches, which at this time was thoroughly saturated with water. The slides were undoubtedly due to the porous character of the material which was placed in the embankments during construction. The embankment was repaired and strengthened by excavating a trench 10 feet deep, 1½ feet wide at the bottom and 3½ feet wide at the top, through the centre of the embankment for a distance of 170 feet, and filling the trench with a mixture of loam and clay thoroughly consolidated for a depth of 7 feet, the remaining 3 feet being filled with gravel, sand and loam. At the same time a blind drain 345 feet long was constructed across land of the Commonwealth and land of Charles Nixon for the purpose of carrying off water which collected on the surface of the ground below the filter-beds.

The filter-beds which receive the drainage from the Worcester County Training School at Oakdale have been operated continuously and satisfactorily during the year. The small filter-beds which receive the drainage from a few small cottages at Sterling Junction were in use from April 23 to November 1, inclusive.

During the year about 1,000 notices, setting forth certain restrictions and regulations adopted by the Board in connection with the protection of the waters and property, have been posted throughout the marginal lands of the several reservoirs and along the several aqueducts. The notices are 17 inches x 28 inches in size, printed on cloth, in letters which can be easily read at a considerable distance. The notices at the Wachusett, Sudbury, Hopkinton, Ashland and Framingham No. 2 reservoirs and along the open channel of the Wachusett Aqueduct are worded as follows, with the exception that smoking on the grounds is forbidden about the Wachusett Reservoir: —



Metropolitan - Water - Works

WACHUSETT RESERVOIR

BATHING
BOATING
FISHING WITHOUT A PERMIT
BUILDING FIRES
HUNTING
TRAPPING
SNARING
SMOKING
ON THE PREMISES OF THE COMMONWEALTH
AND ANY ACTS TENDING TO
POLLUTE THE WATERS
—OR—
INJURE THE PROPERTY
OF THE COMMONWEALTH
ARE PROHIBITED

(Signed) WILLIAM N. DAVENPORT, Secretary
*Metropolitan Water and Sewerage Board*
1 Ashburton Place, Boston, Mass.

[illegible]

At the other reservoirs the notices are similar, but at Spot Pond and the Weston Reservoir fishing, picknicking and skating are also prohibited, and fishing is not allowed in Framingham Reservoir No. 3 and the northern division of Lake Cochituate.

## FORESTRY.

In connection with the several reservoirs and aqueducts the Board has under its care and control about 10,000 acres of land, a large part of which is covered with trees. Around the Wachusett Reservoir 1,341 acres of land have been planted with white pines during the past seven years, and considerable numbers of pines have been planted around the Sudbury Reservoir. There are still several hundred acres which it is proposed to plant with pines, but the greater part of the forestal work now consists in the care of the trees which have been planted, the improvement and thinning of forested areas and in the care and improvement of the forest roads.

During the past year an area of 25.7 acres at the Wachusett Reservoir was planted with three-year-old white pine seedlings placed 6 feet apart in each direction. There were used in doing this work about 36,000 white pine seedlings. When the Wachusett Reservoir was constructed two rows of arbor vitæ trees were set parallel with and 25 feet from the shore. A very large proportion of these trees died, and during the past season 11.4 miles, or somewhat less than half of the shore line, have been replanted with 34,050 arbor vitæ trees spaced 3 feet apart in rows 2 feet apart, at a cost of about $29 per mile. The work of cutting trees and brush which interfered with the growth of young pines and the improvement by thinning of older hardwood growths has been continued. About 230 acres of young white pines were treated in this manner, at a cost of $6.50 per acre, and an improvement thinning of about 31 acres of twenty to thirty year old white pines and chestnuts was made, at a cost of $28 per acre.

A mature growth of white pines on about 2½ acres of land lying between Waushacum Street and the west shore of the Stillwater River was cut and manufactured into lumber, a portion of which was sold and a portion used in the construction of sewage carriers at the Clinton sewerage filter-beds. The cost of the labor, teaming and millwork in connection with the cutting of this lumber was $1,227.90. Lumber and cordwood were sold to the amount of $1,206.75, and 20,350 feet of 2-inch white pine plank, valued at $712.25, were obtained for use on the works.

Trees which were destined to be killed by the permanent raising of the level of the water in what are known as the "Lily Ponds," in West Boylston, have been cut and worked into lumber and cordwood.

Maple seedlings have been transplanted from the field to the sides of the highway between Clinton and West Boylston and set 35 feet apart for a distance of nearly 2 miles.

The Flagg nursery now contains 23,350 white pines and 19,350 arbor vitæ. In the Lamson nursery there are 58,100 arbor vitæ.

The following table gives information regarding the marginal and outlying lands belonging to the Board in the Wachusett watershed: —

| | Acres. |
|---|---|
| *Marginal Lands.* | |
| Area of land which was forested when acquired, not since improved, | 1,235 |
| Area of land which was forested when acquired, and since improved, | 240 |
| Area which has been planted with trees, and not cleared, | 622 |
| Area which has been planted with trees, and since cleared, | 719 |
| Area to be planted with trees, | 28 |
| Area open, which will probably not be planted, | 339 |
| Area of marginal strip along shores of reservoir, | 197 |
| | 3,380 |
| *Outlying Lands.* | |
| Area of land which was forested when acquired, | 294 |
| Area of land not available to plant, | 295 |
| Area to be planted with trees, | 339 |
| | 928 |
| Total area, | 4,308 |

The brush and weeds on all forest roads and on highway roadsides at the Wachusett Reservoir have been cut and burned.

Fire patrol service has been maintained throughout the marginal lands of the Wachusett Reservoir during the spring and fall of the year for the protection of the improved timber and young white pine forests. Notwithstanding this precaution three fires occurred in the recently planted white pine stands and one in sprout and timber land. The fires in the white pine stands burned over 8½ acres on the Bullard farm in West Boylston, 9 acres on Carville Hill and 5 acres on the Woods farm, both in Clinton, and destroyed 27,200 white pines, valued at $416. The fourth fire burned over about 50 acres of land on the Gates farm, covered with a sprout growth of no value. Two of the fires were of incendiary origin. Five boys were summoned into court for setting these fires, one of whom was fined $30 and three others were placed on probation for six months.

At the Sudbury Reservoir the forestal work has consisted in planting 5,000 white pines, cutting out brush and undesirable trees from among 20 acres of white pines on Pine Hill and several other points around the reservoir.

At the Ashland Reservoir about 100 white pines were planted on the southerly side of the waste-way. Two hundred white pines were planted at the Hopkinton Reservoir between the filter-beds and the channel of Indian Brook, and 60 on the opposite side of the channel. Around Lake Cochituate and along the Sudbury and Cochituate aqueducts the forest growth has been improved by cutting out underbrush and undesirable trees.

The work of protecting the trees from the ravages of destructive insects has required the expenditure of $8,012.28, distributed as follows: —

| | |
|---|---|
| Spot Pond, | $3,591 05 |
| Chestnut Hill Reservoir, | 918 41 |
| Weston Reservoir and Aqueduct, | 1,419 94 |
| Mystic Lake, pumping station and reservoir, | 313 25 |
| Sudbury and Cochituate aqueducts, | 310 98 |
| Lake Cochituate, | 176 00 |
| Sudbury Reservoir, | 364 00 |
| Whitehall Reservoir, | 4 81 |
| Wachusett Reservoir and Aqueduct, gypsy and brown-tail moths, | 388 67 |
| Wachusett Reservoir, pine-tree weevil, | 525 17 |
| | $8,012 28 |

At Spot Pond six colonies of gypsy moths were discovered on the property of the Board and the caterpillars were very plenty adjoining the property line between the Board and the city of Medford at the south end of the pond. Beginning on June 3 the trees on about 13 acres of land were sprayed with 4,850 gallons of a mixture of arsenate of lead and water.

At Chestnut Hill Reservoir the number of gypsy moths was somewhat larger than during the previous year, due, mainly, to the neglect of adjoining property owners.

At the Weston Reservoir and along the aqueduct to the terminal chamber the trees have not been injured by the moths, but very careful attention and considerable work was required to prevent the caterpillars from entering the property of the Board from the neighboring estates, which were badly infested. About 450 pounds of arsenate of lead were used in spraying trees on 14 acres.

There was a large increase in the number of gypsy moths at Lake

Cochituate, and 4,350 egg clusters were destroyed, as compared with 300 during the previous year.

At the Sudbury Reservoir there was a large increase in the number of brown-tail moths and several colonies of gypsy moths have been recently discovered. The young pines have been also infested with the pine-tree weevil, which necessitates cutting off and burning the infested shoots.

At the Wachusett Reservoir the weevil has caused considerable injury to the young pines.

All the areas planted with pines, aggregating 1,341 acres, were inspected during the month of July, and the affected shoots cut off and burned at a cost of $525.17. The proportion of trees affected varied in different localities from 1 in 25 to 1 in 3.

The nests of the brown-tail moth were removed from trees along the open channel, on the grounds at the Wachusett Dam, at the Clinton sewerage filter-beds and around the upper end of the Wachusett Reservoir at West Boylston and Oakdale in about the same numbers as during the previous year.

## DISTRIBUTING RESERVOIRS.

The distributing reservoirs maintained by the Board are the Weston and Chestnut Hill reservoirs, the Waban Hill and Forbes Hill reservoirs and the Forbes Hill standpipe of the southern high-service system; Spot Pond and the Mystic Reservoir near Tufts College of the northern low-service system; the Fells and Bear Hill reservoirs of the northern high-service system, and the Arlington standpipe of the northern extra high-service system.

### *Weston Reservoir.*

No work has been done at this reservoir other than that required to keep the grounds and buildings in good order. A large part of the work required has been in connection with the protection of the trees and shrubs from the gypsy and brown-tail moths. The reservoir, with its buildings and grounds, is in good condition. The attendant's house was painted.

### *Chestnut Hill Reservoir.*

The buildings and grounds, including the grounds around the two pumping stations, have received the usual care and are in good condition. The cupola of the old effluent gate-house required extensive repairs, and as it appeared to serve no useful or ornamental purpose has been removed and a stone chimney substituted at the apex of the roof.

### *Waban Hill Reservoir.*

The outer slope of the reservoir embankments was given a dressing of fertilizer and the stairway leading to the gate-house was repointed. The reservoir and grounds are in good condition.

### *Forbes Hill Reservoir and Standpipe.*

The woodwork of the standpipe tower was painted during the year. The floor of the tower has gradually disintegrated and should be resurfaced during the coming year. The reservoir has been kept full of water but has not been drawn upon for the supply of the District.

### *Spot Pond, Fells and Bear Hill Reservoirs.*

A foreman and 7 laborers have been employed in operating gates controlling the flow of water, cleaning the screens and caring for and policing the grounds and buildings at these reservoirs. A 22-foot boat, operated by a gasoline engine, has been placed on Spot Pond for use in policing the pond and in driving away the gulls and ducks which congregate on the pond in large numbers at some seasons of the year. On August 15 an electric car line was placed in service, which enables the public to reach the south end of Spot Pond, and since that date, especially on Sundays and holidays, the work of patrolling the shores of the reservoir in order to protect the property of the Board and prevent pollution of the water supply has been greatly increased.

### *Mystic Reservoir.*

The interior of the gate-house has been painted. The reservoir has been used to control the pressure of the water supplied to the town of Arlington.

### *Mystic Lake and Pumping Station.*

The building formerly occupied by the attendant at the lake has been torn down. The exterior woodwork of the old pumping station building has been scraped and partially painted.

### *Arlington Standpipe.*

The grounds around the standpipe have been cared for by the town of Arlington. The standpipe structure has required very little attention. The wooden floor of the gallery around the top of the standpipe has been oiled and a portion of the ironwork of the stairway has been painted.

### PIPE YARDS.

The buildings at Chestnut Hill and Glenwood are in good condition, with the exception that the exterior woodwork of the buildings at Glenwood will require painting during the coming year.

### PIPE LINES.

The length of pipe lines owned and operated by the Metropolitan Water and Sewerage Board was increased by 7.88 miles during the year, making the total on December 31, 1909, 92.53 miles. The length of mains 4 inches in diameter and larger connected with the works but owned and operated by the several cities and towns supplied with water is 1,602.62 miles.

Thirty-three leaks have been repaired on the pipe lines maintained by the Board, at a cost of $1,540.42, not including sums paid in two cases for damages to private property by water which flowed from broken pipes. At 2.30 P.M. on May 25 the 48-inch main in Franklin Street, Brighton, broke and caused the flooding of property in the immediate neighborhood. This break was repaired at a cost of $223.83 and $215 were paid on account of damage to property. On December 24, at 9.30 P.M., a break occurred in the same 48-inch pipe line in Harvard Square, in Cambridge. A section of the pipe about 6 feet long and 4 feet wide was blown from the side of the pipe, resulting in the escape of a large volume of water for a period of about 1¼ hours. Many buildings in the vicinity were flooded, some of which contained valuable goods. The main was repaired and refilled in readiness for use at midnight of the following day. The cost of the repairs was $459.07. The cost of the damage to property will approximate $20,000. Of the remaining leaks 23 occurred from loosened leaded joints. Two in Pearl Street, Somerville, were caused by defective joints on the 30-inch wrought-iron, cement-lined main, and two occurred at leaded joints in the 36-inch main crossing the Mystic River. One was caused by a defective 48-inch wood joint on Beacon Street, in Brookline.

The abolition of the grade crossing of the Boston & Maine Railroad at Pleasant Street, in Malden, has necessitated the temporary and permanent relocation of the 30-inch high-service main in Pleasant Street. In order that the water supply might be maintained without interruption in Everett, Chelsea, Revere, Winthrop and other towns in the northern high-service district while the lowering of the street was in progress, a temporary line of 24-inch pipe about 1,000 feet long was laid around the site of the work between June 18 and July 18, and after the street had been lowered the 30-inch main was relaid for a distance of 590 feet and connected with the 30-inch pipes at either end. The final connections were made and the temporary main abandoned on August 22. A considerable portion of the labor in connection with excavating and moving the pipes was done by the Boston & Maine Railroad. The cost of materials and labor furnished by this department was $2,295.66, which is to be paid by the Railroad Company as a portion of the cost of abolishing the grade crossing.

The construction of the subway in Massachusetts Avenue, in Cambridge, has necessitated the relocation of the 48-inch main between Central Square and Norfolk Street. By agreement with the Boston Elevated Railway Company, which bears the expense of the changes, a new line of 48-inch pipe is to be laid in Prospect and Austin streets, crossing over the subway in Central Square. This line, which is about 1,200 feet long, will be connected with the existing main at the corner of Austin and Norfolk streets and on Magazine Street, and the present pipe in Massachusetts Avenue and Norfolk Street abandoned. About 950 feet of this pipe have been laid in Prospect and Austin streets by the Hugh Nawn Contracting Company, under the supervision of this department. The laying of the pipes over the subway and making the necessary connections will not be done until spring. It is expected that the construction of the subway will also necessitate changes in the 48-inch main at Harvard Square during the coming year.

The maintenance of the water in the Charles River at grade 8 by the closing of the Charles River Dam has made necessary the re-enforcement of the riprap on the shore at the pipe crossing near the foot of Magazine Street in Cambridge.

A 48-inch wooden insulating joint was substituted for the rubber joint on Middlesex Avenue in Medford, at a cost of $297.

The ironwork on the bridge supporting the 48-inch main over the Boston & Maine Railroad at Walnut Street in Somerville has been scraped and painted with two coats of red lead and one coat of Smith's compound. The sheet lead $\frac{1}{16}$ of an inch thick, with which the lower chord of the bridge girders was covered in 1907 as a protection against the gases from the locomotives, was replaced with lead $\frac{1}{8}$ of an inch in thickness, as holes had been worn through the thinner lead by the cinder blast from the engine smoke stacks.

A portion of the plank floor was relaid on the bridge over the Boston & Maine Railroad at College Avenue in Medford.

In addition to connections made on account of the laying of new mains a 16-inch connection was made in Malden Square between the 30-inch high-service main and a 12-inch main of the city of Malden, to be used only for supplying water for the extinguishment of fires.

A connection with the Chelsea pipe system on Powderhorn Hill was enlarged from 8 inches to 12 inches in order to furnish an ample supply for a special fire service main laid by the city of Chelsea for the protection of several large manufacturing plants.

## METERING OF WATER TO MUNICIPALITIES.

On December 31, 1909, there were 60 Venturi meters, 4 Hersey disc, 1 Hersey torrent and 1 Hersey detector meters, 1 Crown and 3 Union rotary meters connected with the pipe system for use in measuring the water supplied to the several municipalities in the Metropolitan District. These meters have been read and inspected twice each week, and repaired when necessary by a force of 2 men, with occasionally an assistant. Reports have been made monthly to the several municipalities supplied with water, giving the quantities used, and special reports have been made from time to time of the increased use due to leakage or other causes. The throat of the meter through which the town of Lexington is supplied has been reduced in diameter from 4¼ inches to 3 inches, that of the meter supplying the Chelsea high-service district from 5 inches to 3½ inches, and that of one of the meters supplying the high-service district in Malden, located at the junction of Cross and Hancock streets, from 4 inches to 2¾ inches. A new 12-inch meter with a 2½-inch throat has been installed at the junction of Highland Avenue and Clifton Street in Malden. All of these changes were made necessary by the reduced rates of consumption during the night, caused by the reduction of waste.

On May 5 a 3-inch Hersey torrent-meter was set on Clifton Street at the line between Revere and Saugus, for use in measuring the water supplied from the Revere pipe system to a small section of the town of Saugus.

The meter used for measuring the water consumed in Winthrop was moved from the corner of Atlantic and Crescent avenues in Beachmont to the Winthrop-Revere line on October 23. The register chamber used with this meter and the chamber used with the meter located at the corner of Cross and Hancock streets in Malden have been covered with cork and pitch, to prevent freezing of the registering apparatus.

### PRESSURE REGULATORS AND RECORDING GAGES.

The number of automatic regulators used for reducing the pressure in the mains and for controlling the elevation of the water in standpipes and reservoirs was at the end of the year 8, one more than for the previous year.

The 10-inch regulator used to control the pressure in Winthrop and the level of the water in Breed's Island standpipe was repaired and moved to the Revere-Winthrop line, and an 8-inch regulator of the Metropolitan Water Works type was set on the pipe supplying Breed's Island.

The other regulators in use have been overhauled and adjusted.

The recording pressure gages connected with the Distribution System have been in constant use, and the average maximum and minimum elevations of the water, due to the pressure at nineteen points in different parts of the District, are given in Appendix No.

4, Table No. 42. These gages furnish valuable records of both the amount and time of changes in pressure due to breaks in the mains, or other causes.

## ELECTROLYSIS.

On account of the large amount of construction work in progress the electrical survey covering the entire Distribution System, which has been made nearly every year since 1898, to determine the conditions governing electrolytic action on the Metropolitan Water Works pipe lines, was not made during the past year.

Measurements made during the latter part of 1908 showed that considerable electricity was flowing past the 48-inch insulating joint located in Middlesex Avenue in Medford on the north shore of the Mystic River, indicating that the rubber insulation in this joint had failed. During the latter part of March this joint was removed from the pipe line, and upon examination the rubber gasket was found to be hard and black in spots, with a cinder-like appearance, as if it had been carbonized. This joint had been in service since January 10, 1905, and the condition of the rubber gasket appeared to be similar to that of the rubber gasket removed from the insulating joint in Porter Square, Cambridge, in August, 1906. Several of the nuts on the bolts of the Middlesex Avenue joint were badly eaten by electrolytic action, and the positive section of the joint contained numerous electrolytic pittings about 3/8 of an inch in depth. Electrolytic pittings from 1/8 to 3/8 of an inch in depth were also found on two lengths of 48-inch pipe on the north or positive side of the joint. On March 24 this rubber joint was replaced by a wooden joint, which stopped further flow of electricity over the pipe lines at this point.

Recent measurements at four other 48-inch joints that have the rubber insulation show that considerable electricity is flowing past them, and indicate that the rubber gaskets on these joints have also failed in the same manner as in the two joints which have already been removed. One of these joints is located on North Harvard Street in Brighton on the south shore of the Charles River, one in Franklin Street near Lincoln Street in Brighton, one in Boylston Street in Cambridge on the north shore of the Charles River, and the other in the Francis estate in Brighton on the south shore of the Charles River. The joints in North Harvard and Franklin streets should be replaced with wooden joints early in the coming year, but it will not be necessary to replace the other two joints as the electrical conditions have changed since they were set.

On all new pipe lines laid during the past year wooden staves have been substituted for lead and jute in making the joints at intervals of about 500 feet for the purpose of reducing the electrical conductivity of the pipe line, also on all connections with other lines to prevent the flow of current between the lines. In carrying out this policy ten 60-inch, twenty 48-inch, three 36-inch, twenty-four 24-inch, seven 16-inch, four 12-inch and one 6-inch joints have been set during the year. The pipes used for making the joints differ from the ordinary form only by being cast without any lead groove in the bell or bead on the spigot end. A wooden ring is placed in the bell to prevent metallic contact between the ends of the pipes, and the space ordinarily filled with lead and jute is filled with pine staves. The cost of these joints has been approximately as follows: 60-inch $12.45, 48-inch $10.55, 36-inch $8.40, 24-inch $6.15, 16-inch $5.05, 12-inch $4.35 each.

All of the wood insulating joints installed this year in the new 48-inch low-service main in Beacon Street, between the effluent gatehouse at Chestnut Hill Reservoir and Coolidge Corner, a distance of about 8,900 feet, were provided with No. 10 by-pass wires arranged so that measurements of the efficiency of the joints in preventing the flow of electricity could be made after the pipe line was placed in service. By means of these by-pass wires the fall of potential and the current at each joint can be accurately measured at any time, and by connecting the by-pass wires so as to short-circuit all of the joints an approximate idea is obtained of the quantity of electricity that would flow over the main if no insulating joint had been set in the line. As it was not practicable to put in by-pass wires with as low resistance as that of the lead joint, the quantity of electricity flowing on the pipe line when the insulating joints are short circuited in this way is somewhat less than it would be if the joints were all of lead, but the results obtained are instructive and of value in showing that the effect of the joints is at least greater than the apparent efficiency shown by the observations.

The investigation of the effect of the insulating joints installed on this portion of the 48-inch pipe line is not yet entirely completed, but the information already obtained indicates that the amount of current now flowing on the pipe line is less than 10 per cent. of the quantity which would flow if the insulating joints had not been used.

No excavations were made during the year for the purpose of examining pipe lines for corrosion. The pipe cut out of the westerly low-service main in repairing break in Harvard Square on December 25 contained numerous shallow pittings from 1/8 to 1/4 of an inch in depth, most of which were located near the bottom of the pipe and near the underground conduit containing railway return cables.

The examination of the easterly low-service 48-inch main at a point just north of the insulating joint on Middlesex Avenue, in Medford, showed that the corrosion of the pipe at this place is gradually increasing, but probably has not yet progressed far enough to endanger the safety of the pipe line. The districts where the most serious corrosion is now going on are near the Harvard power station of the Boston Elevated Railway Company at Boylston Street, Cambridge, and near the power stations of the Boston & Northern Street Railway Company in Chelsea and Lynn, where measurements made during the year show conditions similar to those found a year ago. As the 12-inch pipe in Washington Street, Lynn, was relaid in 1904 on account of electrolytic corrosion which had taken place in a period of six years, it will be desirable to have this pipe examined during the coming year.

### CLINTON SEWERAGE.

The Clinton sewage-disposal works were in daily operation throughout the year. The quantity of sewage pumped to the filter-beds was 854,000 gallons per day, an increase of 67,000 gallons per day over the preceding year. This increase was due in part to the large amount of surface water which entered the sewers during the months of April and May, and in part to the natural increase in the quantity of sewage due to the extension of the sewerage system in the town of Clinton. The daily average quantities pumped each month were as follows: —

| | Gallons. | | Gallons. |
|---|---|---|---|
| January, | 692,000 | July, | 664,000 |
| February, | 927,000 | August, | 687,000 |
| March, | 960,000 | September, | 658,000 |
| April, | 1,312,000 | October, | 696,000 |
| May, | 1,201,000 | November, | 715,000 |
| June, | 955,000 | December, | 795,000 |

Following are statistics relating to the operation of the pumping station: —

| | |
|---|---|
| Daily average quantity of sewage pumped (gallons), | 854,000 |
| Daily average quantity of coal consumed (pounds), | 1,490 |
| Gallons pumped per pound of coal, | 573 |
| Number of days pumping, | 365 |

| | |
|---|---|
| Cost of pumping: — | |
| Labor, | $1,723 41 |
| Fuel, | 1,210 25 |
| Repairs and supplies, | 258 44 |
| Total for station, | $3,192 10 |

| | |
|---|---|
| Cost per million gallons pumped, | $10.240 |
| Cost per million gallons raised 1 foot high, | 0.206 |

Notwithstanding an increase of 8.5 per cent. in the quantity pumped, the cost of operating the station was only about 1 per cent. more than during the preceding year.

### *Filter-beds.*

The sewage was applied on the filter-beds in practically the same manner as during the preceding year. The beds were used in rotation throughout the year except as interrupted by work on the extension of the underdrainage system and the placing of carriers on the surface of the beds. Each bed has received an average of 61,600 gallons of sewage in thirty minutes about twice in three days. All of the beds were used during the winter, and for this use furrows about 1 foot in depth were made on the surface of the beds 3 feet 6 inches apart. The eight settling basins into which the sewage is pumped previous to being applied to the filter-beds were used in rotation continuously throughout the year in the same manner as described in the report for 1908. The sludge collected in these basins, amounting to about 900 cubic yards, has been used on grass lands belonging to the Board on the North and South dikes and near the Wachusett Dam.

The results of the chemical analyses of the sewage and effluent are given in the following table: —

[Parts per 100,000.]

| | 1904. | 1905. | 1906. | 1907. | 1908. | January to June, 1909, inclusive. | July to December, 1909, inclusive. | Whole Year 1909. |
|---|---|---|---|---|---|---|---|---|
| Albuminoid ammonia, sewage,. | .7967 | 1.1250 | .8558 | .8442 | .5735 | .7067 | .7783 | .7425 |
| Albuminoid ammonia, effluent, | .0686 | .0787 | .0955 | .0744 | .0554 | .0916 | .0722 | .0819 |
| Per cent. removed, . . . | 91 | 93 | 89 | 91 | 90 | 87 | 91 | 89 |
| Oxygen consumed, sewage, . | 8.57 | 13.11 | 9.84 | 7.87 | 3.43 | 6.12 | 7.95 | 7.04 |
| Oxygen consumed, effluent, . | .99 | 1.126 | 1.34 | 1.07 | .765 | 1.17 | 1.16 | 1.165 |
| Per cent. removed, . . . | 88 | 91 | 86 | 87 | 78 | 81 | 85 | 83 |
| Free ammonia, sewage, . . | 3.97 | 4.7533 | 3.5650 | 3.8342 | 4.6193 | 3.8533 | 5.4033 | 4.6283 |
| Free ammonia, effluent, . . | .99 | .9588 | 1.2723 | 1.3176 | 1.3722 | 1.6217 | .9617 | 1.2917 |
| Per cent. removed, . . . | 75 | 80 | 64 | 66 | 70 | 58 | 82 | 70 |
| Nitrogen as nitrates, effluent, . | .4046 | .2665 | .1445 | .1664 | .1468 | .0688 | .3950 | .2319 |
| Iron, effluent, . . . . | 1.2941 | 1.6230 | 2.1042 | 2.2454 | 1.8100 | 2.1800 | 1.3467 | 1.7633 |

The increase in the amount of nitrates and the decrease in the amount of iron in the effluent, especially during the latter half of the year, indicate that the addition of filtering area and the installation of underdrains and carriers, which were begun in 1908 and continued in 1909, have tended to improve the efficiency of the beds. It is expected that still further improvement will be shown when carriers have been installed over the remaining beds.

During the past year a new bed, known as bed No. 7, has been graded, and bed No. 9, which has heretofore been of little value on account of the poor quality of the filtering material and the nearness of the ground water to the surface of the bed, has been raised 3 feet and underdrained.

Four lines of 6-inch vitrified pipe underdrains were laid under bed No. 9 and two lines under 15 other beds, together with the necessary lamp holes and manholes.

Carriers with concrete bottoms and plank sides have been built on 7 of the 24 beds and the beds regraded so as to secure a uniform distribution of the sewage over the surface of each bed.

The following table shows the amount of work done during the year: —

| | Quantity. | Cost. |
|---|---|---|
| 6-inch vitrified pipe underdrain laid with cement joints, | 985.5 lin. ft. | $0.353 per ft. |
| 6-inch vitrified pipe underdrain laid with gravel joints, | 7,586.5 lin. ft. | |
| 6-inch lamp holes laid with cement joints, | 384.0 lin. ft. | |
| Brick manholes, | 3 | |
| Earth excavation, | 7,620 cu. yds. | $0.286 per yd. |
| Earth excavation, grading bed No. 7, | 630 cu. yds. | $0.425 per yd. |
| Concrete carriers on 7 beds, | 1,309.2 lin. ft. | $0.937 per ft. |

The above work was done by day-labor forces between June 7 and October 18, at a total cost of $7,109.85, which includes the cost of all materials used, and is divided among the principal items as follows: —

| | |
|---|---|
| Laying 6-inch vitrified pipe, | $3,165 37 |
| Building brick manholes, | 125 36 |
| Earth excavation, | 2,450 72 |
| Building concrete carriers, | 1,226 43 |
| Miscellaneous, | 141 97 |
| Total, | $7,109 85 |

During the past two years the effective filtering area has been increased from 23 to 25 acres; 13,128 feet of 6-inch vitrified pipe underdrains have been laid in 23 of the 24 beds and concrete carriers for the better distribution of the sewage have been placed on 7 of the beds. The total amount expended on these improvements during the two years was $9,880.84. Concrete carriers are to be placed upon the remaining 17 beds during the coming year.

The cost of maintaining the filter-beds, exclusive of the cost of improving the beds, laying underdrains and building carriers, has been as follows: —

| | |
|---|---|
| Labor, | $3,091 02 |
| Repairs and supplies, | 131 13 |
| Total, | $3,222 15 |
| Cost per million gallons treated, | 10 43 |

Daily tests of the sewage and effluent, to determine the amount of dissolved oxygen and iron, have been made by the keeper in charge of the beds.

## Engineering.

The greater portion of the time of the engineering force is now devoted to matters pertaining to the maintenance and operation of the works. The more important of these matters are the superintendence of the operation of the Venturi meters and of the flow of water from the several reservoirs through the aqueducts; the determination of the quantities of water used in the several municipalities; the tabulation of the records of rainfall as measured at twelve stations on the works, of the elevations of the several storage and distributing reservoirs, and of the pressures in the mains at different points in the Metropolitan District; the making of calculations to determine the yield of the several watersheds, the quantities delivered by the several aqueducts, the quantities pumped at the several pumping stations, and the cost of pumping, the testing of coal and oil, and the examination of the pipes to determine the injury from electrolytic action.

Special engineering work done during the past year has included the making of surveys and the preparation of plans and specifications for works for conveying the surface drainage of the village of Cochituate outside the Cochituate watershed; the superintendence of the construction of additional beds and the laying of underdrains and concrete carriers at the Clinton sewerage filter-beds; the preparation of plans and the giving of lines and grades in connection with the improvement of Lake Cochituate.

## Cement Tests.

The results of the tests of cements used in the construction of the Wachusett Aqueduct, the Wachusett Dam and Reservoir and the Weston Aqueduct from 1896 to 1905 were published in the annual reports of the Board until 1906. As the results of tests of cements used in the construction of the distributing works have never been published, and as the results of 7½-year and 10-year tests on other works are now available, it has been thought advisable to publish the later tests in the present report. They will be found in Appendix No. 3.

Appended to this report are tables giving the amount of work done and other information relative to contracts, tables giving long-time tests of cements, and a long series of tables relating to the maintenance of the Metropolitan Water Works, including the rainfall, yield of sources of supply, consumption of water in the different districts, the number of service pipes, meters and fire hydrants in the Metropolitan Water District, and a summary of statistics for 1909.

Respectfully submitted,

DEXTER BRACKETT,

*Chief Engineer.*

BOSTON, January 1, 1910.

# REPORT OF CHIEF ENGINEER OF SEWERAGE WORKS.

*To the Metropolitan Water and Sewerage Board.*

GENTLEMEN: — The following is a report of the operations of the Engineering Department of the Metropolitan Sewerage Works for the year ending December 31, 1909.

## ORGANIZATION.

The engineering organization during the year has been as follows: —

*Division Engineers:* —

| | |
|---|---|
| FREDERICK D. SMITH, . | *In charge of maintenance and construction, South Metropolitan System.* |
| FRANK I. CAPEN, . . | *In charge of maintenance and construction, North Metropolitan System.* |

*Assistant Engineer:* —

| | |
|---|---|
| HENRY T. STIFF, . . | *In charge of office and drafting room.* |

In addition to the above, there were employed at the end of the year 12 engineering and other assistants.

# METROPOLITAN SEWERAGE DISTRICTS.

## AREAS AND POPULATIONS.

During the year no changes have been made in the extent of the sewerage districts. The area of the North Metropolitan District remains at 90.50 square miles, and of the South Metropolitan District at 100.87 square miles, — a total, inclusive of water surfaces, of 191.37 square miles. These districts include the whole or parts of 25 cities and towns, as set forth in the following table.

The populations in the table are based on the census of 1905.

*Table showing Areas and Estimated Populations within the Metropolitan Sewerage District, as of December 31, 1909.*

| CITY OR TOWN. | | Area (Square Miles). | | Estimated Population. | |
|---|---|---|---|---|---|
| North Metropolitan District. | Arlington, | 5.20 | | 10,820 | |
| | Belmont, | 4.66 | | 5,060 | |
| | Boston (portions of), | 3.45 | | 97,757 | |
| | Cambridge, | 6.11 | | 105,000 | |
| | Chelsea, | 2.24 | | 36,300 | |
| | Everett, | 3.34 | | 33,760 | |
| | Lexington,[1] | 5.11 | | 4,550 | |
| | Malden, | 5.07 | | 41,640 | |
| | Medford, | 8.35 | | 22,190 | |
| | Melrose, | 3.73 | | 15,470 | |
| | Revere, | 5.86 | | 15,120 | |
| | Somerville, | 3.96 | | 76,160 | |
| | Stoneham, | 5.50 | | 6,810 | |
| | Wakefield, | 7.65 | | 11,480 | |
| | Winchester, | 5.95 | | 9,500 | |
| | Winthrop, | 1.61 | | 9,260 | |
| | Woburn, | 12.71 | | 14,520 | |
| | | | 90.50 | | 515,397 |
| South Metropolitan District. | Boston (portions of), | 20.39 | | 181,230 | |
| | Brookline, | 6.81 | | 27,500 | |
| | Dedham,[1] | 9.40 | | 8,050 | |
| | Hyde Park, | 4.57 | | 15,650 | |
| | Milton, | 12.59 | | 7,920 | |
| | Newton, | 16.88 | | 44,000 | |
| | Quincy, | 12.56 | | 31,970 | |
| | Waltham, | 13.63 | | 29,050 | |
| | Watertown, | 4.04 | | 12,810 | |
| | | | 100.87 | | 358,180 |
| Totals, | | | 191.37 | | 873,577 |

[1] Part of town.

# METROPOLITAN SEWERS.

## SEWERS PURCHASED AND CONSTRUCTED AND THEIR CONNECTIONS.

Within the Sewerage Districts there are now 101.985 miles of Metropolitan sewers. Of this total, 8.79 miles of sewers, with the Quincy pumping station, have been purchased from cities and towns of the districts, the remaining 93.195 miles of Metropolitan sewers and other works having been constructed by the Metropolitan boards.

The locations, lengths and sizes of these sewers are given in the following tables, together with other data referring to the public and special connections with the system: —

*North Metropolitan System.*

| CITY OR TOWN. | Size of Sewers. | Length in Miles. | Public Connections, December 31, 1900. | Special Connections. | |
|---|---|---|---|---|---|
| | | | | Character or Location of Connection. | Number in Operation. |
| Boston: — | | | | | |
| Deer Island, | 6' 3", to 9', | 1.367 | 4 | – | – |
| East Boston, | 9' to 1', | 5.467 | 23 | Shoe factory, | 1 |
| Charlestown, | 6' 7"×7' 5" to 1', | 3.292 | 14 | Navy Yard, | 8 |
| | | | | Almshouse, | 1 |
| Winthrop, | 9', | 2.864 | 11 | Club House, | 1 |
| | | | | Fire Dept. Station, | 1 |
| | | | | Private Building, | 1 |
| Chelsea, | 8' 4"×9' 2" to 1' 10"×2' 4", | 5.123 | 9 | Bakery, | 1 |
| | | | | Rendering works, | 1 |
| | | | | Metropolitan Water Works blow-off, | 3 |
| Everett, | 8' 2"×8' 10" to 4' 8"×5' 1", | 2.925 | 6 | Metropolitan Water Works blow-off, | 1 |
| | | | | Cameron Appliance Co., | 1 |
| | | | | Shultz-Goodwin Co., | 1 |
| Malden, | 4' 6"×4' 10" to 1' 3", | 4.493[1] | 28 | Metropolitan Water Works blow-off, | 1 |
| | | | | Private buildings, | 140 |
| Melrose, | 4' 6"×4' 10" to 10", | 6.099[2] | 34 | Private buildings, | 109 |
| | | | | Factory, | 1 |
| | | | | Railroad station, | 1 |
| Cambridge, | 5' 2"×5' 9" to 1' 3", | 7.167 | 31 | Slaughter house, | 1 |
| | | | | City Hospital, | 2 |
| Somerville, | 6' 5"×7' 2" to 1' 10"×2' 3", | 3.471 | 10 | Tannery, | 1 |
| | | | | Slaughter-houses (3), | 1 |
| | | | | Car-house, | 1 |
| | | | | Street railway power house, | 1 |
| | | | | Stable, | 1 |
| | | | | Rendering works, | 1 |
| Medford, | 4' 8"×5' 1" to 10", | 5.359 | 21 | Armory building, | 1 |
| | | | | Private buildings, | 8 |
| | | | | Stable, | 1 |
| | | | | Police sub-station, | 1 |
| Winchester, | 2' 11"×3' 3" to 1' 3", | 6.428 | 13 | Tannery, | 2 |
| | | | | Private buildings, | 2 |
| | | | | Gelatine factory, | 1 |
| | | | | Stable, | 1 |
| | | | | Railroad station, | 1 |
| Stoneham, | 1' 3" to 10", | 0.010 | 4 | – | – |
| Woburn, | 1' 10"×2' 4" to 1' 3", | 0.933 | 3 | Glue factory, | 1 |

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[1] Includes .988 of a mile of sewer purchased from the city of Malden.

[2] Includes .736 of a mile of sewer purchased from the city of Melrose.

## *North Metropolitan System* — Concluded.

| CITY OR TOWN. | Size of Sewers. | Length in Miles. | Public Connections, December 31, 1909. | SPECIAL CONNECTIONS. Character or Location of Connection. | SPECIAL CONNECTIONS. Number in Operation. |
|---|---|---|---|---|---|
| Arlington, | 1′ 6″ to 10″, | 3.520[1] | 35 | Private buildings, | 128 |
|  |  |  |  | Railroad station, | 1 |
|  |  |  |  | Car-house, | 3 |
|  |  |  |  | Post Office, | 1 |
| Belmont,[2] | – | – | 3 | – | – |
| Wakefield,[2] | – | – | 1 | – | – |
| Revere, | 4′ to 3′, | 0.048 | 2 | – | – |
|  |  | 58.566[3] | 252 |  | 434 |

## *South Metropolitan System.*

| CITY OR TOWN. | Size of Sewers. | Length in Miles. | Public Connections, December 31, 1909. | Character or Location of Connection. | Number in Operation. |
|---|---|---|---|---|---|
| Boston (Back Bay), | 6′ 6″ to 3 ′ 9″, | 1.500[4] | 13 | Tufts Medical School, | 1 |
|  |  |  |  | Private house, | 1 |
|  |  |  |  | Administration Building, Boston Park Department, | 1 |
|  |  |  |  | Simmons College buildings, | 1 |
|  |  |  |  | Art Museum, | 2 |
| Boston (Brighton), | 5′ 9″×6′ 0″ to 12″, | 6.010[5] | 11 | Abattoir, | 3 |
| Boston (Dorchester). | 3′×4′ to 2′ 6″×2′ 7″, | 2.870[6] | 10 | Chocolate works, | 2 |
|  |  |  |  | Machine shop, | 1 |
|  |  |  |  | Paper mill, | 1 |
|  |  |  |  | Private buildings, | 2 |
| Boston (Roxbury), | 6′ 6″×7′, 4′ 0″, | 1.430 | – | – | – |
| Boston (West Roxbury). | 9′ 3″×10′ 2″ to 12″, | 7.600 | 9 | Parental school, | 1 |
|  |  |  |  | Lutheran Evangelical Church, | 1 |
|  |  |  |  | Private buildings, | 4 |
| Brookline, | 6′ 6″×7′ 0″ to 8″ | 2.540[7] | 10 | – | – |
| Dedham, | 4′×4′ 1″ to 3′ 9″×3′ 10″, | 2.350 | 5 | – | – |
| Hull, | 60″ pipe, | 0.750 | – | – | – |
| Hyde Park, | 10′ 7″×11′ 7″ to 4′×4′ 1″, | 4.527 | 15 | Mattapan Paper Mills, | 1 |
|  |  |  |  | Private buildings, | 2 |
| Milton, | 11′×12′ to 8″, | 3.600 | 16 | – | – |
| Newton, | 4′ 2″×4′ 9″ to 1′ 3″, | 2.911 | 6 | Private houses, | 2 |
| Quincy, | 11′3″×12′ 6″ to 24″ pipe, | 6.580 | 6 | – | – |
| Waltham, | 3′ 6″×4′, | 0.001 | 1 | – | – |
| Watertown, | 4′ 2″×4′ 9″ to 12″, | 0.750[8] | 5 | Factories, | 2 |
|  |  |  |  | Stanley Motor Carriage Co., | 1 |
|  |  | 43.419 | 107 |  | 29 |

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[1] Includes 2.631 miles of sewer purchased from the town of Arlington.

[2] The Metropolitan sewer extends but a few feet into the towns of Belmont and Wakefield.

[3] Includes 2.787 miles of Mystic River valley sewer in Medford, Winchester and Woburn, running parallel with the Metropolitan sewer.

[4] Includes .355 of a mile of sewer purchased from the city of Boston.

[5] Includes .446 of a mile of pipe and concrete sewers built for the use of the city of Boston; also, .026 of a mile of sewer purchased from the town of Watertown.

[6] Includes 1.24 miles of sewer purchased from the city of Boston.

[7] Includes .158 of a mile of pipe sewer built for the use of the town of Brookline.

[8] Includes .025 of a mile of sewer purchased from the town of Watertown.

## COST OF CONSTRUCTION.

[To December 31, 1909.]

The cost of the 101.985 miles of Metropolitan sewers enumerated above, including six pumping stations, screen-house, siphons and appertaining structures, may be summarized as follows: —

| | |
|---|---|
| North Metropolitan System, . . . . . . . . | $6,312,130 61 |
| South Metropolitan System, . . . . . . . . | 8,785,297 80 |
| | $15,097,428 41 |

Information relating to areas, populations, local sewer connections and other data for the whole Metropolitan Sewerage District appear in the following table: —

| Area (Square Miles). | Estimated Total Population. | Miles of Local Sewer connected. | Estimated Population contributing Sewage. | Ratio of Contributing Population to Total Population (Per Cent.). | CONNECTIONS MADE WITH METROPOLITAN SEWERS. | |
|---|---|---|---|---|---|---|
| | | | | | Public. | Special. |
| *North Metropolitan District.* | | | | | | |
| 90.50 | 515,397 | 652.56 | 445,637 | 86.5 | 252 | 434 |
| *South Metropolitan District.* | | | | | | |
| 100.87 | 358,180 | 524.01 | 233,025 | 65.1 | 107 | 29 |
| *Entire Metropolitan District.* | | | | | | |
| 191.37 | 873,577 | 1,176.57 | 678,662 | 77.7 | 359 | 463 |

Of the estimated gross population of 873,577 on December 31, 1909, 678,662, representing 77.7 per cent., were on that date contributing sewage to the Metropolitan sewers, through a total length of 1,176.57 miles of local sewers owned by the individual municipalities. These sewers are connected with the Metropolitan System by 359 public and 463 special connections. It appears, also, that there has been during the year an increase of 44.21 miles of local sewers connected with the Metropolitan System, and that 19 public and 14 special connections have been added.

### Pumping Stations and Pumpage.

The following table shows the average daily volume of sewage lifted at each of the six Metropolitan pumping stations during the year, as compared with the corresponding volumes for the previous year: —

| PUMPING STATION. | Average Daily Pumpage. | | | |
|---|---|---|---|---|
| | Jan. 1, 1908, to Dec. 31, 1908. | Jan. 1, 1909, to Dec. 31, 1909. | Increase during the Year. | |
| | Gallons. | Gallons. | Gallons. | Per Cent. |
| Deer Island, | 59,800,000 | 60,600,000 | 800,000 | 1.3 |
| East Boston, | 57,800,000 | 58,600,000 | 800,000 | 1.4 |
| Charlestown, | 31,300,000 | 32,100 000 | 800,000 | 2.6 |
| Alewife Brook, | 3,627,000 | 3,358,000 | 269,000 | 7.4[1] |
| Quincy, | 3,687,000 | 4,163,000 | 476,000 | 12.9 |
| Ward Street (actual gallons pumped), | 22,300,000 | 22,700,000 | 400,000 | 1.8 |

[1] Decrease.

# CONSTRUCTION.

## NORTH METROPOLITAN SYSTEM.

Chapter 556 of the legislative Acts of 1908 provided an appropriation of $445,000 for extensions and additions to the East Boston and Deer Island pumping stations.

Chapter 582 of the legislative Acts of 1908 provided $40,000 for the restoration of the existing East Boston pumping station, damaged during the great Chelsea fire of April 12, 1908.

### Construction at Deer Island Station.

Under the above-mentioned Acts, construction for the extensions of the coal and engine houses at Deer Island had been started during the year 1908. As outlined in the last report, the foundations for the extensions had been completed and changes made in the roads and connecting manholes near the station and on the discharge sewer.

During the present year miscellaneous grading has been done by day labor, under the direction of the Chief Engineer, about the extensions to the coal and engine houses; the manholes at connections with the discharge sewer have been completed, and a 60-inch cast-iron discharge pipe placed from the engine house extension to the discharge sewer, with Venturi meter and controlling valves. Masonry floors for the basement and main engine room extension, with concrete foundations for an additional engine and four boilers have been built by day labor. Work by day labor on a by-pass channel on the main sewer under the screen-house, to provide for additional screens, is in progress at the date of this report. It is anticipated it may be completed in March.

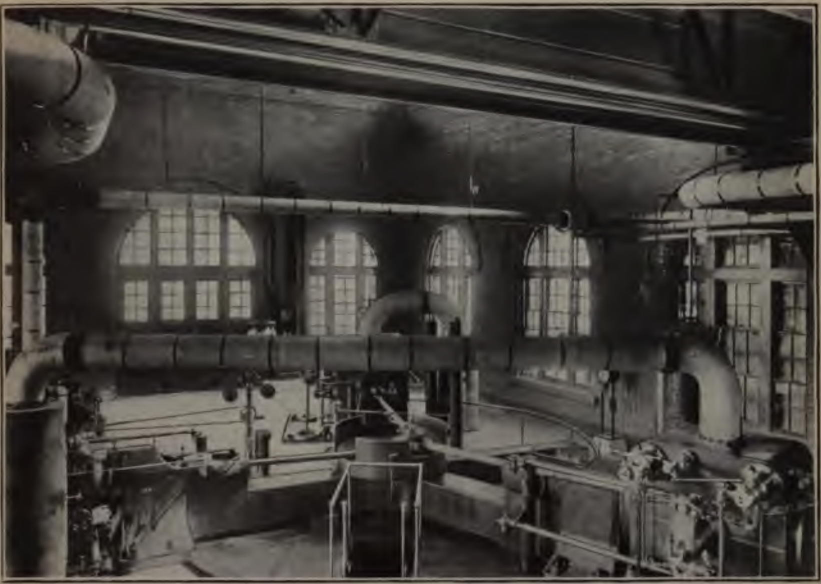
A contract for the masonry superstructures for the coal and engine house extensions was made on March 8, 1909, with Walter A. Wentworth Company. This contract provided for a masonry coal house 103 feet long and 35 feet wide, and a new engine room 50 feet long and 46 feet wide. The work under this contract was completed early in September.

On November 2, 1908, a contract was made with the Allis-Chalmers Company of Milwaukee for one 100,000,000-gallon centrifugal pump and engine with four horizontal, tubular boilers, from special design by F. W. Dean, with piping and appurtenances. The boilers were constructed for the contractor by the Robb-Mumford Boiler Company of South Framingham. The boilers were delivered and placed on the foundations during the summer and fall. Castings for the pump and engine were delivered at Deer Island early in September. At the date of this report the whole pumping plant and appurtenances provided for in the Allis-Chalmers contract have been substantially completed in condition for carrying out the tests specified in the contract.

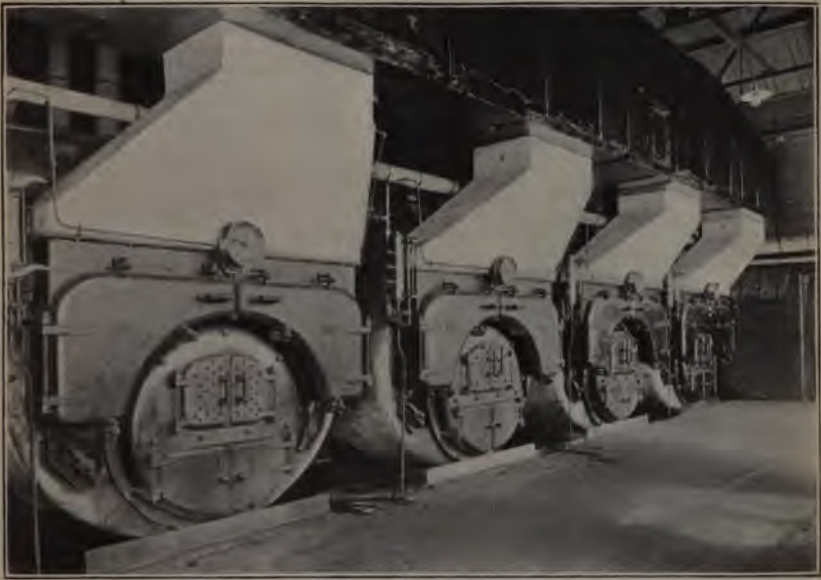
## CONSTRUCTION AT EAST BOSTON STATION.

Under the before-noted legislative Acts, the East Boston pumping station, destroyed by the fire of April 12, 1908, was temporarily repaired, in condition to be operated, within a few weeks from the date of the fire.

On August 13, 1909, a contract was made with the Woodbury & Leighton Company for permanent repairs to the existing East Boston station, and for making extensions to engine and boiler houses and a new coal house. As permanently developed, the station will be fireproof, with concrete roof and floors, masonry walls, steel doors and window frames. The station to be built will be 268 feet in



NEW ENGINE AT DEER ISLAND SEWERAGE PUMPING STATION.



NEW BOILERS AT DEER ISLAND SEWERAGE PUMPING STATION.

length and 65 feet in width. This makes provision for a fourth centrifugal pumping engine of 100,000,000 gallons capacity, with six new boilers, dynamo room, machine shop and storage for 1,500 tons of coal. The walls of the station are to be brick, laid largely in Portland cement, with granite trimmings.

At the date of this report the outside walls of the old buildings have been refaced with 4 inches of brick, laid in Portland cement and securely bonded to the old walls. A new granite base course and granite trimmings have been introduced. The masonry foundations for the extensions of the station are about half completed. It is anticipated the station building may be completed by September 1, 1910.

On June 5, 1909, a contract was made with the Allis-Chalmers Company of Milwaukee for one 100,000,000-gallon centrifugal pump and engine for the East Boston station, to be placed on foundations furnished by the Board, to be in condition for regular service in the house not later than June, 1911.

On December 15, 1909, a contract was made with the Robb-Mumford Boiler Company of South Framingham for six vertical, internally fired boilers, from special designs by F. W. Dean, to be delivered, on foundations furnished by the Board, on or before September 1, 1910.

Construction by day labor, under the direction of the Engineer, has been carried out at the station during the year, involving modifications of the discharge tube from the third engine, to avoid interference with the walls of the proposed extension of the engine house. This has involved breaking out a length of this tube, moving the 48-inch cast-iron check valve, rebuilding the tube and replacing the valve.

The foundation walls on the Chelsea Creek side of the existing engine house were badly scarred and cracked in the fire of April 12, 1908. During the year a sheet of reinforced Portland concrete about 8 inches thick has been anchored to the face of the wall and the walls grouted. The concrete reinforcement extends from a depth of 2 feet below the bed of the creek to the top of the foundation walls.

Masonry heads of the large controlling manholes about the station and screen-house were badly scarred and cracked in the fire. During the year the scarred granite heads of these chambers have been removed and replaced with concrete. The foundation of the screen-house along Addison Street and over the screen pits has been further strengthened by additional girders. These bearing and supporting beams for the screen-house and machinery have been surrounded and reinforced with concrete by day labor.

## SOUTH METROPOLITAN SYSTEM.

### Extension of the High-level Sewer through West Roxbury, Brookline and Brighton.

This extension, authorized by chapter 406 of the Acts of 1906, involving a length of 5.64 miles of main sewers, was fully completed March 5, 1909.

During the year it has been put into service and at the date of the report important areas of Brookline are draining into it.

### *Section 81, Brookline.*

*Division Engineer in Charge.* — Seth Peterson.

*Contractors.* — Bruno & Petitti, Contract No. 60 (Sta. 0 to 21 + 40). Hugh Nawn Contracting Company, Contract No. 61 (Sta. 21 + 40 to 34 + 15).

This section extends from near the boundary line between West Roxbury and Brookline, near the junction of Chestnut Street and Pond Avenue, along Chestnut, Kendall and Cypress streets to Boylston Street, in Brookline, — a distance of 3,415 feet.

The contract with Bruno & Petitti, extending from the town line along Chestnut and Kendall streets, — a distance of 2,140 feet, was practically completed at the date of the last report except for replacing street surfaces. The town of Brookline resurfaced the whole street over the line of this section with bitulithic and macadam pavement. The contractor for this section arranged with the town of Brookline to make the necessary repairs along the sewer trenches during the months of May and June.

### *Section 85, Brighton.*

*Division Engineer in Charge.* — Frank I. Capen.

*Superintendent of Construction by Day Labor.* — Chas. A. Haskin (Sta. 0 to 11 + 42).

*Contractors.* — George M. Bryne Company, Contract No. 63 (Sta. 11 + 42 to 24 + 00). D. F. O'Connell Company, Contract No. 64 (Sta. 24 + 00 to 47 + 00). Hugh Nawn Contracting Company, Contract No. 65 (Sta. 47 + 00 to 63 + 50).

This section extends from near Allston Street, along Commonwealth Avenue, Warren, Cambridge and Washington streets, to near Lake Street, — a distance of 6,350 feet. The lower portion of this section was constructed by the Board by day labor. Three contracts were made for the construction of the remainder of the section.

The day-labor section and sections by George M. Bryne Company and Hugh Nawn Contracting Company were completed prior to the date of this report. On the D. F. O'Connell section about 30 feet of tunnel near the shaft remained to be lined and the shaft refilled and surface completed. This was completed February 13, 1909.

### *Section 86, Brighton.*

*Division Engineer in Charge.* — FRANK I. CAPEN.

*Contractors.* — GLENN & BRODERICK, Contract No. 66, for 1,650 linear feet of 12-inch pipe sewer and 715 linear feet of 42-inch concrete sewer. CHARLES J. JACOBS COMPANY, Contract No. 67, for 1,305 linear feet of 69-inch × 72-inch concrete sewer and 1,135 linear feet of 72-inch × 48-inch reinforced concrete sewer.

This section extends westerly through Washington Street from a point about 200 feet east of Lake Street to Nonantum Street, at Oak Square, — a distance of 2,440 linear feet.

A contract for the construction of the main sewer for this section was made with the Charles J. Jacobs Company on August 4, 1908. On January 1, 1909, the work remaining comprised about 70 linear feet of trench excavation and the placing of the masonry for a length of 113 feet.

This work, except for street surfaces, was completed March 5, 1909. By arrangement with the Contractor, the Street Department of the city of Boston during the summer months placed a new street surface over the entire length of this section.

## MAINTENANCE.

### SCOPE OF WORK AND FORCE EMPLOYED.

The maintenance of the Metropolitan Sewerage System includes the operation of 7 stations and 101.985 miles of Metropolitan sewers, receiving the discharge from 1,176.57 miles of town and city sewers at 359 points, together with the care and study of inverted siphons under streams and in the harbor.

The permanent maintenance force of 148 men includes 88 engineers and other employés at the pumping stations, and 60 men employed on actual sewer maintenance and care of pumping station grounds. In the following three tables the use of the completed systems and other data are shown: —

## NORTH METROPOLITAN SYSTEM.

*Table showing Cities and Towns delivering Sewage in this System; Approximate Miles of Sewer connected; Estimated Populations and Areas now contributing; Total Areas ultimately to contribute, and Present Populations on Such Areas; Ratios of Present Contributing Areas to Ultimate Areas, and Ratios of Populations now contributing to Present Total Populations.*

[Populations estimated as of December 31, 1909.]

| CITIES AND TOWNS. | Miles of Local Sewer connected. | Separate or Combined. | Number of Connections with Local Sewers. | Estimated Number of Persons served by Each House Connection.[1] | Estimated Population now contributing Sewage. | Estimated Present Total Population. | Estimated Area now contributing Sewage. | Area ultimately to contribute Sewage. | Ratio of Contributing Population to Present Total Population. | Ratio of Contributing Area to Ultimate Area. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Sq. Miles. | Sq. Miles. | Per Cent. | Per Cent. |
| Boston (Deer Island), . | 0.70 | Separate, . . . | – | – | 1,497[2] | 1,497[2] | – | – | 100.0 | – |
| Winthrop, . . . | 29.04 | Separate, . . . | 2,235 | 4.10 | 9,160 | 9,260 | 1.27 | 1.61 | 98.9 | 79.0 |
| Boston (East Boston), . | 30.01 | Separate and combined, | 4,466 | 12.00 | 53,590 | 56,100 | 1.06 | 2.18 | 95.5 | 48.6 |
| Chelsea, . . . . | 28.98[3] | Separate and combined, | 3,165[4] | 9.40 | 29,750 | 36,300 | 1.09 | 2.24 | 82.0 | 48.7 |
| Everett, . . . . | 43.43 | Separate and combined, | 4,209 | 6.55 | 27,570 | 33,760 | 1.88 | 3.34 | 81.7 | 56.3 |
| Malden, . . . . | 52.31 | Separate, . . . | 5,237 | 5.80 | 30,370 | 41,640 | 2.69 | 5.07 | 72.9 | 53.1 |
| Melrose, . . . . | 35.34 | Separate, . . . | 2,681 | 4.50 | 12,065 | 15,470 | 1.74 | 3.73 | 78.0 | 46.7 |
| Boston (Charlestown), . | 21.16 | Separate and combined, | 5,236 | 7.65 | 40,055 | 40,160 | 0.67 | 1.27 | 99.7 | 52.8 |
| Cambridge, . . . | 142.16 | Separate and combined, | 15,126 | 6.85 | 103,610 | 105,000 | 4.99 | 6.11 | 98.7 | 81.7 |
| Somerville, . . . | 93.70 | Separate and combined, | 13,994 | 5.40 | 75,570 | 76,160 | 3.31 | 3.96 | 99.2 | 83.6 |
| Medford, . . . | 51.70 | Separate, . . . | 3,801 | 5.65 | 21,475 | 22,190 | 2.78 | 8.35 | 96.8 | 33.3 |
| Winchester, . . . | 23.52 | Separate, . . . | 1,164 | 5.70 | 6,635 | 9,500 | 1.14 | 5.95 | 69.8 | 19.2 |
| Woburn, . . . . | 13.64[5] | Separate, . . . | 1,040 | 5.40 | 5,615 | 14,520 | 0.94 | 12.71 | 38.7 | 7.4 |
| Stoneham, . . . | 11.58 | Separate, . . . | 712 | 4.50 | 3,205 | 6,810 | 0.62 | 5.50 | 47.1 | 11.3 |
| Arlington, . . . | 20.75 | Separate, . . . | 1,175 | 6.20 | 7,285 | 10,820 | 1.67 | 5.20 | 67.3 | 32.1 |
| Belmont, . . . | 12.82 | Separate, . . . | 505 | 6.20 | 3,660[6] | 5,060 | 1.03 | 4.66 | 72.3 | 22.1 |
| Wakefield, . . . | 11.34 | Separate, . . . | 517 | 5.80 | 3,000 | 11,480 | 0.43 | 7.65 | 26.1 | 5.6 |
| Lexington,[7] . . . | – | – – | – | – | – | 4,550 | – | 5.11 | – | – |
| Revere, . . . . | 30.38 | Separate, . . . | 2,216 | 5.20 | 11,525 | 15,120 | 1.69 | 5.86 | 76.2 | 28.8 |
| Totals, . . . | 652.56 | – – | 67,479 | 6.60 | 445,637 | 515,397 | 29.00 | 90.50 | 86.5 | 32.0 |

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[1] Estimated from assessors' statement of the number of houses in each city or town, and the population from census of 1905 extended to May 1, 1909.

[2] Estimated by Superintendent James H. Cronin of the Institution on Deer Island.

[3] The districts connecting at Cypress Street, Revere Beach Parkway, Springvale Avenue, Willoughby, Bellingham, Highland, Hawthorn and Spruce streets are now contributing sewage.

[4] Estimated.

[5] Exclusive of Mystic River valley sewer and tanneries.

[6] Including 2 connections with McLean Hospital, having an estimated population of 530.

[7] Lexington not connected.

## SOUTH METROPOLITAN SYSTEM.

*Table showing Cities and Towns delivering Sewage to this System; Approximate Miles of Sewer connected; Estimated Populations and Areas now contributing; Total Areas ultimately to contribute, and Present Populations on Such Areas; Ratios of Present Contributing Areas to Ultimate Areas, and Ratios of Populations now contributing to Present Total Populations.*

[Populations estimated as of December 31, 1909.]

| CITIES AND TOWNS. | Miles of Local Sewer connected. | Separate or Combined. | Number of Connections with Local Sewers. | Estimated Number of Persons served by Each House Connection.[1] | Estimated Population now contributing Sewage. | Estimated Present Total Population. | Estimated Area now contributing Sewage. | Area ultimately to contribute Sewage. | Ratio of Contributing Population to Present Total Population. | Ratio of Contributing Area to Ultimate Area. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Sq. Miles. | Sq. Miles. | Per Cent. | Per Cent. |
| Boston (Back Bay), | 24.29 | Separate and combined, | 1,591 | 23.10 | 36,750 | 37,100 | 1.23 | 1.61 | 99.1 | 76.4 |
| Boston (Brighton), | 54.61 | Separate and combined, | 2,885 | 6.10 | 17,600 | 26,000 | 3.16 | 3.74 | 67.7 | 84.5 |
| Brookline, | 63.29 | Separate and combined, | 3,487 | 7.50 | 26,150 | 27,500 | 3.38 | 6.81 | 95.1 | 49.6 |
| Newton, | 107.24 | Separate, | 5,638 | 6.60 | 37,210 | 44,000 | 7.04 | 16.88 | 84.6 | 41.7 |
| Watertown, | 34.39 | Separate, | 1,773 | 5.50 | 9,750 | 12,810 | 1.89 | 4.04 | 76.1 | 46.8 |
| Waltham, | 42.86 | Separate, | 3,396 | 7.85 | 26,660 | 29,050 | 2.20 | 13.63 | 91.8 | 16.1 |
| Boston (Dorchester), | 47.97 | Separate and combined, | 4,548 | 6.70 | 30,470 | 52,150 | 2.30 | 4.89 | 58.4 | 47.0 |
| Milton, | 8.59 | Separate and combined, | 351 | 5.50 | 1,930 | 7,920 | 0.43 | 12.59 | 24.4 | 3.4 |
| Hyde Park, | 24.75 | Separate, | 1,384 | 7.70[2] | 10,655 | 15,650 | 1.21 | 4.57 | 68.1 | 26.5 |
| Dedham, | 14.39 | Separate, | 483 | 4.90 | 2,365 | 8,050[3] | 0.73 | 9.40 | 29.4 | 7.8 |
| Boston (Roxbury), | – | – – | – | – | – | 35,650 | – | 1.23 | – | – |
| Boston (West Roxbury), | 45.59 | Separate and combined, | 2,530 | 6.75 | 18,025[4] | 30,330 | 2.17 | 8.92 | 59.4 | 24.3 |
| Quincy, | 56.04 | Separate, | 2,917 | 5.30 | 15,460 | 31,970 | 2.63 | 12.56 | 48.4 | 20.9 |
| Totals, | 524.01 | – – | 30,983 | 7.50 | 233,025 | 358,180 | 28.37 | 100.87 | 65.1 | 28.1 |

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[1] Estimated from assessors' statement of the number of houses in each city or town, and the population from census of 1905 extended to May 1, 1909.

[2] Estimated by City Engineer.

[3] Part of town not included in Metropolitan Sewerage District.

[4] Including connection with Institution at Austin Farm having an estimated population of 945.

## WHOLE METROPOLITAN SYSTEM.

*Table showing Areas delivering Sewage to the Entire System, inclusive of Added High-level Area; Approximate Miles of Sewer connected; Estimated Populations and Areas now contributing; Total Areas ultimately to contribute, and Present Populations on Such Areas; Ratios of Present Contributing Areas to Ultimate Areas, and Ratios of Populations now contributing to Present Total Populations.*

[Populations estimated as of December 31, 1909.]

| SYSTEM. | Miles of Local Sewer connected. | Separate or Combined. | Number of Connections with Local Sewers. | Estimated Number of Persons served by Each House Connection. | Estimated Population now contributing Sewage. | Estimated Present Total Population. | Estimated Area now contributing Sewage. | Area ultimately to contribute Sewage. | Ratio of Contributing Population to Present Total Population. | Ratio of Contributing Area to Ultimate Area. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Sq. Miles. | Sq. Miles. | Per Cent. | Per Cent. |
| North Metropolitan, . | 652.56 | Separate and combined, | 67,479 | 6.60 | 445,637 | 515,397 | 29.00 | 90.50 | 86.5 | 32.0 |
| South Metropolitan, . | 524.01 | Separate and combined, | 30,983 | 7.50 | 233,025 | 358,180 | 28.37 | 100.87 | 65.1 | 28.1 |
| Totals, . . . | 1,176.57 | - - | 98,462 | 6.90 | 678,662 | 873,577 | 57.37 | 191.37 | 77.7 | 30.0 |

## CAPACITY AND RESULTS.

The following tables summarize the pumping records for the year for the Metropolitan sewerage stations: —

## North Metropolitan System.

### *Deer Island Pumping Station.*

At this station are three submerged centrifugal pumps, with impellers or wheels 8.25 feet in diameter, driven by triple-expansion engines of the Reynolds-Corliss type.

**Contract capacity of pumps:** 45,000,000 gallons each, with 19-foot lift.
**Average duty for the year:** 49,100,000 foot-pounds.
**Average quantity raised each day:** 60,600,000 gallons.
**Force employed:** 4 engineers, 4 firemen, 3 oilers, 3 screenmen and 1 relief screenman.
**Coal used:** Davis and New River, costing from $3.785 to $4.21 per gross ton.

*Table of Approximate Quantities, Lifts and Duties at the Deer Island Pumping Station of the North Metropolitan System.*

| MONTHS. | Total Pumpage (Gallons). | Average per Day (Gallons). | Minimum Day (Gallons). | Maximum Day (Gallons). | Average Lift (Feet). | Average Duty (ft.-lbs. per 100 lbs. Coal). |
|---|---|---|---|---|---|---|
| 1909. | | | | | | |
| January, | 1,887,300,000 | 60,900,000 | 45,900,000 | 91,800,000 | 10.38 | 50,300,000 |
| February, | 2,156,000,000 | 77,000,000 | 47,800,000 | 138,300,000 | 10.82 | 48,000,000 |
| March, | 2,250,500,000 | 72,600,000 | 58,100,000 | 103,800,000 | 10.85 | 45,900,000 |
| April, | 1,987,500,000 | 66,300,000 | 55,600,000 | 105,600,000 | 10.47 | 50,400,000 |
| May, | 1,840,300,000 | 59,400,000 | 46,200,000 | 91,000,000 | 10.54 | 49,200,000 |
| June, | 1,854,400,000 | 61,800,000 | 44,400,000 | 92,700,000 | 10.39 | 56,000,000 |
| July, | 1,597,000,000 | 51,500,000 | 45,200,000 | 70,700,000 | 10.11 | 49,500,000 |
| August, | 1,599,000,000 | 51,600,000 | 42,800,000 | 83,900,000 | 10.21 | 51,500,000 |
| September, | 1,734,000,000 | 57,800,000 | 44,100,000 | 94,400,000 | 10.24 | 48,000,000 |
| October, | 1,503,400,000 | 48,500,000 | 38,800,000 | 63,600,000 | 10.31 | 48,800,000 |
| November, | 1,640,600,000 | 54,700,000 | 37,400,000 | 139,500,000 | 11.15 | 49,700,000 |
| December, | 2,011,900,000 | 64,900,000 | 49,600,000 | 109,100,000 | 11.28 | 41,600,000 |
| Total, | 22,061,900,000 | - | - | - | - | - |
| Average, | - | 60,600,000 | 46,300,000 | 98,700,000 | 10.56 | 49,100,000 |

## *East Boston Pumping Station.*

At this station are three submerged centrifugal pumps, with impellers or wheels 8.25 feet in diameter, driven by triple-expansion engines of the Reynolds-Corliss type.

Contract capacity of pumps: 45,000,000 gallons each, with 19-foot lift.
Average duty for the year: 48,600,000 foot-pounds.
Average quantity raised each day: 58,600,000 gallons.
Force employed: 4 engineers, 4 firemen, 3 oilers, 3 screenmen, 1 relief screenman and 3 helpers.
Coal used: Davis and New River, costing from $3.26 to $3.915 per gross ton.

*Table of Approximate Quantities, Lifts and Duties at the East Boston Pumping Station of the North Metropolitan System.*

| MONTHS. | Total Pumpage (Gallons). | Average per Day (Gallons). | Minimum Day (Gallons). | Maximum Day (Gallons). | Average Lift (Feet). | Average Duty (ft.-lbs. per 100 lbs. Coal). |
|---|---|---|---|---|---|---|
| **1909.** | | | | | | |
| January, | 1,825,300,000 | 58,900,000 | 43,900,000 | 89,800,000 | 15.69 | 45,300,000 |
| February, | 2,100,000,000 | 75,000,000 | 45,800,000 | 136,300,000 | 15.99 | 48,300,000 |
| March, | 2,188,400,000 | 70,600,000 | 56,100,000 | 101,800,000 | 16.08 | 49,700,000 |
| April, | 1,928,000,000 | 64,300,000 | 53,600,000 | 103,600,000 | 15.92 | 49,700,000 |
| May | 1,778,300,000 | 57,400,000 | 44,200,000 | 89,000,000 | 16.83 | 47,200,000 |
| June, | 1,794,400,000 | 59,800,000 | 42,400,000 | 90,700,000 | 15.32 | 44,000,000 |
| July, | 1,535,000,000 | 49,500,000 | 43,200,000 | 68,700,000 | 15.42 | 50,700,000 |
| August, | 1,537,000,000 | 49,600,000 | 40,800,000 | 81,900,000 | 15.35 | 53,000,000 |
| September, | 1,674,000,000 | 55,800,000 | 42,100,000 | 92,400,000 | 15.07 | 44,600,000 |
| October, | 1,441,000,000 | 46,500,000 | 36,800,000 | 61,600,000 | 15.44 | 50,200,000 |
| November, | 1,580,600,000 | 52,700,000 | 35,400,000 | 137,500,000 | 15.16 | 48,200,000 |
| December, | 1,949,900,000 | 62,900,000 | 47,600,000 | 107,100,000 | 15.16 | 51,700,000 |
| Total, | 21,331,900,000 | - | - | - | - | - |
| Average, | - | 58,600,000 | 44,300,000 | 96,700,000 | 15.62 | 48,600,000 |

### *Charlestown Pumping Station.*

At this station are three submerged centrifugal pumps, two of them having impellers or wheels 7.5 feet in diameter, the other 8.25 feet in diameter. They are driven by triple-expansion engines of the Reynolds-Corliss type.

Contract capacity of pumps: two, 22,000,000 gallons each, with 11-foot lift; one 60,000,000 gallons, with 8-foot lift.

Average duty for the year: 51,000,000 foot-pounds.

Average quantity raised each day: 32,100,000 gallons.

Force employed: 4 engineers, 4 firemen, 3 oilers, 3 screenmen and 1 relief screenman.

Coal used: Davis and New River, costing from $3.70 to $3.995 per gross ton.

*Table of Approximate Quantities, Lifts and Duties at the Charlestown Pumping Station of the North Metropolitan System.*

| MONTHS. | Total Pumpage (Gallons). | Average per Day (Gallons). | Minimum Day (Gallons). | Maximum Day (Gallons). | Average Lift (Feet). | Average Duty (ft.-lbs. per 100 lbs. Coal). |
|---|---|---|---|---|---|---|
| 1909. | | | | | | |
| January, | 1,014,200,000 | 32,700,000 | 24,300,000 | 51,000,000 | 8.26 | 50,000,000 |
| February, | 1,060,800,000 | 37,900,000 | 27,600,000 | 61,900,000 | 8.26 | 51,000,000 |
| March, | 1,065,700,000 | 34,400,000 | 26,300,000 | 46,700,000 | 8.25 | 48,900,000 |
| April, | 1,031,800,000 | 34,400,000 | 27,500,000 | 54,800,000 | 8.23 | 49,700,000 |
| May, | 978,400,000 | 31,600,000 | 24,100,000 | 47,200,000 | 8.15 | 50,300,000 |
| June, | 969,500,000 | 32,300,000 | 24,900,000 | 45,000,000 | 8.05 | 53,600,000 |
| July, | 894,300,000 | 28,800,000 | 23,500,000 | 37,700,000 | 8.04 | 50,700,000 |
| August, | 941,400,000 | 30,400,000 | 24,100,000 | 49,100,000 | 8.18 | 54,400,000 |
| September, | 934,900,000 | 31,200,000 | 22,900,000 | 52,900,000 | 8.12 | 52,800,000 |
| October, | 825,500,000 | 26,600,000 | 21,300,000 | 36,500,000 | 7.98 | 48,500,000 |
| November, | 892,700,000 | 29,800,000 | 22,800,000 | 60,500,000 | 7.83 | 50,000,000 |
| December, | 1,069,500,000 | 34,500,000 | 26,800,000 | 61,900,000 | 8.08 | 52,600,000 |
| Total, | 11,678,700,000 | - | - | - | - | - |
| Average, | - | 32,100,000 | 24,700,000 | 50,400,000 | 8.12 | 51,000,000 |

### *Alewife Brook Pumping Station.*

The plant at this station consists of the original installation of small commercial pumps and engines, *i.e.,* two 9-inch Andrews vertical centrifugal pumps, with direct-connected compound marine engines, together with the recent additions. The latter consists of a specially designed engine of the vertical cross-compound type, having between the cylinders a centrifugal pump rotating on a horizontal axis.

Contract capacity of the two original pumps: 4,500,000 gallons each, with 13-foot lift.
Contract capacity of new pump: 13,000,000 gallons, with 13-foot lift.
Average duty for the year: 18,100,000 foot-pounds.
Average quantity raised each day: 3,358,000 gallons.
Force employed: 3 engineers, 1 relief engineer, 2 screenmen, and 1 relief screenman.
Coal used: first-quality Cumberland and Davis, costing from $4.23 to $4.56 per gross ton.

*Table of Approximate Quantities, Lifts and Duties at the Alewife Brook Pumping Station of the North Metropolitan System.*

| MONTHS. | Total Pumpage (Gallons). | Average per Day (Gallons). | Minimum Day (Gallons). | Maximum Day (Gallons). | Average Lift (Feet). | Average Duty (ft.-lbs. per 100 lbs. Coal). |
|---|---|---|---|---|---|---|
| 1909. | | | | | | |
| January, | 89,826,000 | 2,898,000 | 2,330,000 | 5,106,000 | 12.99 | 16,200,000 |
| February, | 127,813,000 | 4,565,000 | 2,645,000 | 7,757,000 | 12.54 | 20,500,000 |
| March, | 157,701,000 | 5,100,000 | 3,478,000 | 7,580,000 | 12.68 | 24,300,000 |
| April, | 127,351,000 | 4,245,000 | 3,279,000 | 6,813,000 | 12.70 | 21,000,000 |
| May, | 115,830,000 | 3,736,000 | 2,978,000 | 5,882,000 | 12.72 | 18,900,000 |
| June, | 107,559,000 | 3,585,000 | 2,550,000 | 6,206,000 | 12.56 | 20,300,000 |
| July, | 77,854,000 | 2,511,000 | 2,078,000 | 3,766,000 | 12.91 | 17,700,000 |
| August, | 63,007,000 | 2,033,000 | 1,616,000 | 3,622,000 | 12.78 | 14,300,000 |
| September, | 74,542,000 | 2,485,000 | 1,784,000 | 4,983,000 | 12.78 | 15,200,000 |
| October, | 68,228,000 | 2,201,000 | 1,868,000 | 2,598,000 | 12.84 | 13,600,000 |
| November, | 80,453,000 | 2,682,000 | 1,952,000 | 7,167,000 | 12.71 | 15,400,000 |
| December, | 132,156,000 | 4,263,000 | 3,330,000 | 7,344,000 | 12.63 | 20,100,000 |
| Total, | 1,222,320,000 | - | - | - | - | - |
| Average, | - | 3,358,000 | 2,491,000 | 5,735,000 | 12.74 | 18,100,000 |

## SOUTH METROPOLITAN SYSTEM.

### *Ward Street Pumping Station.*

At this station are two vertical, triple-expansion pumping engines, of the Allis-Chalmers type, operating reciprocating pumps, the plungers of which are 48 inches in diameter with a 60-inch stroke.

**Contract capacity of pumps:** 50,000,000 gallons each, with 45-foot lift.
**Average duty for the year:** 84,200,000 foot-pounds.
**Average quantity raised each day:** 22,700,000 gallons.
**Force employed:** 4 engineers, 4 firemen, 4 oilers, 4 assistant engineers, 1 machinist and 1 laborer.
**Coal used:** Davis and New River, costing from $4.20 to $4.62 per gross ton.

*Table of Approximate Quantities, Lifts and Duties at the Ward Street Pumping Station of the South Metropolitan System.*

| MONTHS. | Total Pumpage (Gallons). | Average per Day (Gallons). | Minimum Day (Gallons). | Maximum Day (Gallons). | Average Lift (Feet). | Average Duty (ft.-lbs. per 100 lbs. Coal). |
|---|---|---|---|---|---|---|
| **1909.** | | | | | | |
| **January**, | 630,660,000 | 20,300,000 | 12,400,000 | 28,100,000 | 40.70 | 82,000,000 |
| **February**, | 846,500,000 | 30,200,000 | 14,900,000 | 38,000,000 | 42.10 | 101,800,000 |
| **March**, | 950,000,000 | 30,600,000 | 13,900,000 | 33,400,000 | 41.34 | 97,400,000 |
| **April**, | 869,800,000 | 29,000,000 | 19,000,000 | 31,200,000 | 41.47 | 90,400,000 |
| **May**, | 866,000,000 | 27,900,000 | 16,400,000 | 29,100,000 | 41.09 | 87,900,000 |
| **June**, | 707,300,000 | 23,500,000 | 16,500,000 | 24,500,000 | 40.64 | 86,400,000 |
| **July**, | 595,400,000 | 19,200,000 | 11,400,000 | 22,500,000 | 39.86 | 76,400,000 |
| **August**, | 542,600,000 | 17,500,000 | 9,500,000 | 26,500,000 | 39.78 | 72,500,000 |
| **September**, | 568,800,000 | 19,000,000 | 12,600,000 | 23,700,000 | 40.00 | 71,300,000 |
| **October**, | 486,500,000 | 15,700,000 | 13,000,000 | 16,500,000 | 39.64 | 70,500,000 |
| **November**, | 567,900,000 | 18,900,000 | 13,000,000 | 34,300,000 | 40.07 | 85,300,000 |
| **December**, | 644,200,000 | 20,800,000 | 16,400,000 | 33,400,000 | 40.21 | 88,700,000 |
| Total, | 8,275,600,000 | - | - | - | - | - |
| Average, | - | 22,700,000 | 14,500,000 | 28,400,000 | 40.57 | 84,200,000 |

Records from plunger displacement.
Average slip for the year about 11.0 per cent.

## *Quincy Pumping Station.*

At this station are two compound condensing Deane pumping engines and one Lawrence centrifugal pump driven by a Sturtevant compound condensing engine.

**Contract capacity of pumps:** 3,000,000 Deane; 5,000,000 Deane; 10,000,000 Lawrence centrifugal.
**Average duty for the year:** 34,200,000 foot-pounds.
**Average quantity raised each day:** 4,163,000 gallons.
**Force employed:** 3 engineers, 1 relief engineer, 2 screenmen and 1 relief screenman.
**Coal used:** Davis, costing from $4.055 to $4.48 per gross ton.

*Table of Approximate Quantities, Lifts and Duties at the Quincy Pumping Station of the South Metropolitan System.*

| MONTHS. | Total Pumpage (Gallons). | Average per Day (Gallons). | Minimum Day (Gallons). | Maximum Day (Gallons). | Average Lift (Feet). | Average Duty (ft.-lbs. per 100 lbs. Coal). |
|---|---|---|---|---|---|---|
| **1909.** | | | | | | |
| January, | 121,197,000 | 3,910,000 | 3,020,000 | 4,530,000 | 20.95 | 30,800,000 |
| February, | 137,470,000 | 4,910,000 | 3,870,000 | 6,660,000 | 21.15 | 30,300,000 |
| March, | 159,864,000 | 5,157,000 | 4,410,000 | 6,410,000 | 21.20 | 30,800,000 |
| April, | 155,406,000 | 5,180,000 | 4,650,000 | 5,772,000 | 21.18 | 34,900,000 |
| May, | 150,350,000 | 4,850,000 | 4,025,000 | 5,460,000 | 21.24 | 36,900,000 |
| June, | 124,579,000 | 4,152,000 | 3,500,000 | 4,685,000 | 21.24 | 37,300,000 |
| July, | 116,935,000 | 3,772,000 | 3,320,000 | 4,300,000 | 21.23 | 37,000,000 |
| August, | 109,445,000 | 3,530,000 | 3,080,000 | 3,900,000 | 21.22 | 35,800,000 |
| September, | 107,305,000 | 3,577,000 | 3,245,000 | 4,100,000 | 21.24 | 35,800,000 |
| October, | 108,163,000 | 3,489,000 | 2,940,000 | 5,000,000 | 21.00 | 34,100,000 |
| November, | 100,150,000 | 3,338,000 | 2,770,000 | 5,100,000 | 21.24 | 34,300,000 |
| December, | 126,890,000 | 4,093,000 | 3,720,000 | 4,670,000 | 21.18 | 32,500,000 |
| Total, | 1,517,754,000 | - | - | - | - | - |
| Average, | - | 4,163,000 | 3,546,000 | 5,049,000 | 21.17 | 34,200,000 |

## *Nut Island Screen House.*

The plant at this house includes two sets of screens in duplicate, actuated by small reversing engines of the Fitchburg type. Two vertical Deane boilers, 80 horse-power each, operate the engines, provide heat for the house and burn materials intercepted at the screens.

Average quantity of sewage passing screens daily, 40,400,000 gallons.
Total materials intercepted at screens during the past year, 1,026 cubic yards.
Materials intercepted per million gallons of sewage discharge, 1.88 cubic feet.
Force employed: 3 engineers, 1 relief engineer, 3 screenmen and 1 relief screenman.
Coal used: 383.9 tons Davis and New River, costing from $3.815 to $4.185 per gross ton.

## COST OF PUMPING.

In the following tables the total cost of pumping and the rate per million foot-gallons at each of six pumping stations are shown in detail: —

### *Average Cost per Million Foot-gallons for Pumping at the Deer Island Station.*

Volume (22,061.9 Million Gallons) × Lift (10.56 Feet) = 232,974 Million Foot-gallons.

| ITEMS. | Cost. | Cost per Million Foot-gallons. |
|---|---|---|
| Labor, | $11,914 68 | $0.05114 |
| Coal, | 9,202 34 | .03950 |
| Oil, | 185 34 | .00080 |
| Waste, | 89 32 | .00038 |
| Water, | 1,351 68 | .00580 |
| Packing, | 169 12 | .00073 |
| Miscellaneous supplies and renewals, | 1,105 31 | .00474 |
| Totals, | $24,017 79 | $0.10309 |
| Labor at screens, | - | .01172 |

### *Average Cost per Million Foot-gallons for Pumping at the East Boston Station.*

Volume (21,331.9 Million Gallons) × Lift (15.62 Feet) = 333,204 Million Foot-gallons.

| ITEMS. | Cost. | Cost per Million Foot-gallons. |
|---|---|---|
| Labor, | $15,537 48 | $0.04663 |
| Coal, | 10,743 62 | .03224 |
| Oil, | 316 67 | .00095 |
| Waste, | 70 23 | .00021 |
| Water, | 1,703 34 | .00511 |
| Packing, | 47 88 | .00014 |
| Miscellaneous supplies and renewals, | 1,215 12 | .00365 |
| Totals, | $29,634 34 | $0.08893 |
| Labor at screens, | - | .00819 |

### *Average Cost per Million Foot-gallons for Pumping at the Charlestown Station.*

Volume (11,678.7 Million Gallons) × Lift (8.12 Feet) = 94,831 Million Foot-gallons.

| ITEMS. | Cost. | Cost per Million Foot-gallons. |
|---|---|---|
| Labor, | $11,608 56 | $0.12241 |
| Coal, | 3,528 59 | .03721 |
| Oil, | 172 56 | .00182 |
| Waste, | 92 95 | .00098 |
| Water, | 405 60 | .00428 |
| Packing, | 9 06 | .00009 |
| Miscellaneous supplies and renewals, | 1,036 49 | .01093 |
| Totals, | $16,853 81 | $0.17772 |
| Labor at screens, | – | .02879 |

### *Average Cost per Million Foot-gallons for Pumping at the Alewife Brook Station.*

Volume (1,222.32 Million Gallons) × Lift (12.74 Feet) = 15,572 Million Foot-gallons.

| ITEMS. | Cost. | Cost per Million Foot-gallons. |
|---|---|---|
| Labor, | $5,796 90 | $0.37226 |
| Coal, | 1,528 60 | .09816 |
| Oil, | 112 98 | .00726 |
| Waste, | 45 43 | .00292 |
| Water, | 207 40 | .01332 |
| Packing, | 27 31 | .00175 |
| Miscellaneous supplies and renewals, | 495 73 | .03183 |
| Totals, | $8,214 35 | $0.52750 |
| Labor at screens, oiling and miscellaneous services, | – | .11688 |

### *Average Cost per Million Foot-gallons for Pumping at the Ward Street Station.*

Volume (8,275.6 Million Gallons) × Lift (40.57 Feet) = 335,741 Million Foot-gallons.

| ITEMS. | Cost. | Cost per Million Foot-gallons. |
|---|---|---|
| Labor, | $14,483 27 | $0.04314 |
| Coal, | 7,882 49 | .02348 |
| Oil, | 268 06 | .00080 |
| Waste, | 28 76 | .00009 |
| Water, | 1,443 60 | .00430 |
| Packing, | 188 12 | .00056 |
| Miscellaneous supplies and renewals, | 1,686 00 | .00501 |
| Totals, | $25,980 30 | $0.07738 |
| Labor at screens, | - | .01265 |

### *Average Cost per Million Foot-gallons for Pumping at the Quincy Station.*

Volume (1,517.8 Million Gallons) × Lift (21.17 Feet) = 32,132 Million Foot-gallons.

| ITEMS. | Cost. | Cost per Million Foot-gallons. |
|---|---|---|
| Labor, | $4,731 30 | $0.14724 |
| Coal, | 1,529 11 | .04759 |
| Oil, | 23 69 | .00074 |
| Waste, | 10 96 | .00034 |
| Water, | 229 80 | .00715 |
| Packing, | 27 45 | .00085 |
| Miscellaneous supplies and renewals, | 140 29 | .00437 |
| Totals, | $6,692 60 | $0.20828 |
| Labor at screens, oiling and miscellaneous services, | - | .04862 |

Coal for use at the several stations has been purchased as follows: —

| | GROSS TONS, BITUMINOUS COAL. | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Deer Island Pumping Station. | East Boston Pumping Station. | Charlestown Pumping Station. | Alewife Brook Pumping Station. | Ward Street Pumping Station. | Quincy Pumping Station. | Nut Island Screen House. | Contract Price per Gross Ton. |
| Staples Coal Company, | – | – | 436.3 | – | – | – | – | $3 64 |
| Davis Coal and Coke Company, | – | 1,684.943 | – | – | – | – | – | 3 69 |
| New England Coal and Coke Company. | – | 1,003.084 | – | – | – | – | – | 3 69 |
| Staples Coal Company, | 1,219.25 | – | – | – | – | – | – | 3 74 |
| Staples Coal Company, | – | – | – | – | – | – | 200 | 3 74 |
| Davis Coal and Coke Company, | – | – | 420.218 | – | – | – | – | 3 95 |
| New England Coal and Coke Company. | – | – | 58.078 | – | – | – | – | 3 95 |
| Staples Coal Company, | – | – | – | – | 700.302 | – | – | 4 09 |
| Davis Coal and Coke Company, | 402.55 | – | – | – | – | – | – | 4 15 |
| New England Coal and Coke Company. | 1,115.397 | – | – | – | – | – | – | 4 15 |
| Neponset River Coal Company, | – | – | – | – | – | 144.967 | – | 4 15 |
| New England Coal and Coke Company. | – | – | – | – | – | – | 200 | 4 20 |
| New England Coal and Coke Company. | – | – | – | 67.249 | – | – | – | 4 25 |
| Davis Coal and Coke Company, | – | – | – | – | 782.959 | – | – | 4 41 |
| New England Coal and Coke Company. | – | – | – | – | 140.577 | – | – | 4 41 |
| Davis Coal and Coke Company, | – | – | – | – | – | 87.90 | – | 4 45 |
| New England Coal and Coke Company. | – | – | – | – | – | 116.598 | – | 4 45 |
| Locke Coal Company, | – | – | – | 221.556 | – | – | – | 4 50 |
| Total gross tons, | 2,737.197 | 2,688.027 | 914.596 | 288.805 | 1,623.838 | 349.465 | 400 | – |
| Average price per gross ton, | $3 97 | $3 69 | $3 80 | $4 44 | $4 27 | $4 33 | $3 97 | – |

## NORTH METROPOLITAN SYSTEM.

### SHIRLEY GUT SIPHON.

During the year the continued dredging in the harbor in the vicinity of Shirley Gut has resulted in marked changes in the bed of the harbor near the siphon crossing from Point Shirley to Deer Island. For a length of about 50 feet from the head-house on the Winthrop end, the roof of the sewer siphon had been practically uncovered.

During the year heavy riprap has been placed around the head-house and over the line of the siphon to defend against further moving of the material in the vicinity of this siphon.

## SIPHON UNDER ALEWIFE BROOK.

At the request of the Metropolitan Park Commissioners, who are modifying the channel of Alewife Brook, the 15-inch Metropolitan branch sewer to Arlington, near the Lexington Branch Railroad, has been modified by the introduction of siphon pipes under the new channel of the brook. Two lines of cast-iron pipe, embedded in Portland concrete, have been substituted for the original 15-inch pipe sewer. The siphon pipes are so arranged that the dry-weather sewage flow is concentrated in the smaller pipe, 6 inches in diameter, and the larger pipe, 10 inches in diameter, will not be used until the smaller pipe has become surcharged to a depth of 6 inches.

The siphon pipes are 54 feet in length, and, with the manholes at the ends of the pipe, involve changes over a length of 72 feet, of which 28 feet was on the Arlington sewer. At the ends of the pipes the controlling manholes provide for stop-planks and valves to aid in flushing the siphon pipes if they should become clogged. The effect of this siphon arrangement is to dam up the lower end of the 18-inch local sewer about 6 inches, reducing its carrying capacity to approximately that of a 15-inch pipe.

This work was begun early in November. At that date the water in Alewife Brook was at low level and controlled by pumps of contractors for the Metropolitan Park Commissioners, operating in that vicinity. Shortly after our operations began the contractors abandoned their pumping plants, and this siphon work has been carried out under very adverse conditions of floods in the brook and on surrounding meadows.

At the date of this report the excavation has been completed and the siphon pipes placed. It is anticipated that as early as the first of February the work will be fully completed.

## PIPES UNDER CAMBRIDGE SUBWAY.

Under authority of chapter 520, Acts of 1906, the Boston Elevated Railway Company is constructing a subway through Main Street, in the city of Cambridge. The Cambridge branch of the Metropolitan

Sewer crosses the line of this subway at Portland Street, and the invert of the Metropolitan Sewer is 6 feet above the invert elevation of the subway. The work of passing the Metropolitan Sewer under the subway has been carried out during the year by the Elevated Railway Company.

At the subway crossing the Metropolitan Sewer is about 4 feet 6 inches in diameter. There is a wide variation between the ordinary dry-weather and storm flows in this sewer. For passing the sewage flow under the subway two lines of cast-iron pipes have been placed during the year, — one 20 inches in diameter for the ordinary dry-weather flow, and one 36 inches in diameter, at a higher elevation, for storm flows. The pipes are about 50 feet in length and embedded in Portland concrete. The ends of the pipes above and below the subway are at the same elevation. Masonry structures above and below the subway provide flushing valves, stop-planks and sand sumps for flushing and cleaning and intercepting heavy material that would not be desirable to pass through the pipes.

While the work of placing the pipes was in progress, the sewage flow was concentrated in a wooden box near the easterly side of the sewer. This work was started early in September, and at the date of this report the excavation for the pipes has been made, the pipes placed, and the masonry chambers at both ends of the pipes nearly completed. It seems probable that the sewage flow may be turned through these pipes early in January.

This arrangement of pipes under this subway, with ends at the same elevation, adopted by the Railway Company, will involve additional cost in the maintenance of this Metropolitan branch sewer, and result in a substantial reduction in its carrying capacity above this location.

### Tannery Drainage in Winchester and Woburn.

During the year much labor and expense have been involved in the care of Metropolitan Sewers in Winchester and Woburn. This tannery drainage is rapidly increasing in quantity and its character has been substantially changed within the last few years.

### New Pumps at Alewife Brook Station.

During the year two 9-inch Andrews centrifugal pumps have been introduced, replacing two old pumps of the same size. The cast-iron shells of the old pumps had been worn through. The old pumps had been in service about sixteen years.

## SOUTH METROPOLITAN SYSTEM.

The extension of the High-Level Sewer through West Roxbury, Brookline and Brighton, authorized by chapter 406 of the Acts of 1906, was completed early in the year and opened for service. During the year ten connections have been made with the extension by the town of Brookline, providing for 1,850 acres of its territory, located generally south of the Metropolitan Sewer.

### South Metropolitan Outfalls.

The 60-inch outfall pipes in the harbor have been in operation five years at the date of this report. These pipes are in normal condition and free from deposit. During the past year the average flow through them has been 40,400,000 gallons of sewage per day, with a maximum rate of 135,500,000 gallons in the month of February, 1909.

In October, the diving contractor who placed the 60-inch outfall pipes in the harbor near Nut Island examined these outfalls. He entered the pipes for about 100 feet; he reports the pipes clean and the outfalls in satisfactory condition.

Late in 1908 two Sturtevant electrical generating sets of about 15 horse power capacity each, were introduced at the Nut Island screen-house. These generators have been in successful operation during the year.

### Material Intercepted at the Screens.

The material intercepted at the screens at the North Metropolitan sewerage stations, consisting of rags, paper and other floating matters, has during the year amounted to 2,400 cubic yards. This is equivalent to 2.9 cubic feet for each million gallons of sewage pumped at Deer Island.

The material intercepted at the screens at the South Metropolitan sewerage stations has amounted to 2,342.3 cubic yards, equal to 4.3 cubic feet per million gallons of sewage delivered at the outfall works at Nut Island.

Studies of sewage flows in the Metropolitan sewers, siphons and outfall pipes indicate that they are free from deposit.

Respectfully submitted,

WM. M. BROWN,
*Chief Engineer of Sewerage Works.*

BOSTON, January 1, 1910.

# APPENDIX.

# APPENDIX No. 1.

## STATEMENT OF IMPORTANT EVENTS IN THE CONSTRUCTION AND OPERATION OF THE METROPOLITAN WATER WORKS TO JANUARY, 1, 1910.

| | |
|---|---|
| Metropolitan Water Supply, State Board of Health directed to investigate and report a system, | June 9, 1893. |
| Metropolitan Water Supply, Report of State Board of Health made to Legislature, | Feb. 7, 1895. |
| Metropolitan Water Act passed, | June 5, 1895. |
| Metropolitan Water Board organized, | July 19, 1895. |
| Metropolitan Water Supply, first contract made by the Board (water pipes), | Dec. 27, 1895. |
| Sudbury Reservoir, first taking of land made, | Jan. 4, 1896. |
| Sudbury Reservoir (partially constructed), taken from city of Boston, | Jan. 4, 1896. |
| Wachusett Reservoir, first purchase of lands made (Shaw Place, in Boylston), | Jan. 29, 1896. |
| Wachusett Aqueduct, first contract made, | Feb. 14, 1896. |
| Main water pipes, laying begun, | May 11, 1896. |
| Chestnut Hill high-service pumping station, contract for engine made, | Jan. 1, 1897. |
| Sudbury Reservoir, filling with water begun, | Feb. 8, 1897. |
| Quincy, admitted into Metropolitan Water District, | June 24, 1897. |
| Wachusett Reservoir, first contract made, | July 14, 1897. |
| Chestnut Hill high-service pumping station, addition begun, | Sept. 22, 1897. |
| Chestnut Hill low-service pumping station, contract for three engines made, | Oct. 20, 1897. |
| Wachusett Aqueduct, Assabet Bridge completed, | Nov. 6, 1897. |
| Boston Water Works, taken by Metropolitan Water Board, | Jan. 1, 1898. |
| Spot Pond, taken by Metropolitan Water Board, | Jan. 1, 1898. |
| Metropolitan Water Works, first operated for supplying District, | Jan. 1, 1898. |
| Mystic Water Works, discontinued for regular supply, | Jan. 1, 1898. |
| New 48-inch main connecting Chestnut Hill and Spot Pond, completed, | Jan. 13, 1898. |
| Wachusett Reservoir, waters of South Branch of Nashua River and Sandy Pond taken, | Feb. 23, 1898. |
| Wachusett Aqueduct, substantially completed, | Mar. 7, 1898. |
| Wachusett Aqueduct, water of South Branch of Nashua River diverted, | Mar. 7, 1898. |
| Sudbury Reservoir, filled with water, | April 1898. |

| | |
|---|---|
| Fells Reservoir, construction begun, | May 20, 1898. |
| Wachusett Reservoir, agreement made for acquisition of St. John's Catholic Cemetery in Clinton, | July 1, 1898. |
| Chestnut Hill low-service pumping station, contract for building made, | Aug. 26, 1898. |
| Nahant, admitted into Metropolitan Water District, | Sept. 13, 1898. |
| Spot Pond pumping station, contract for engine made, | Sept. 20, 1898. |
| Swampscott, agreement made to supply with water, | Dec. 2, 1898. |
| Sudbury Reservoir, substantially completed, | Dec. 9, 1898. |
| Chestnut Hill high-service pumping station, new engine first operated, | Dec. 11, 1898. |
| Quincy, supplied with water, | Dec. 31, 1898. |
| Spot Pond pumping station, contract for building made, | Jan. 7, 1899. |
| Arlington, admitted into Metropolitan Water District, | Jan. 31, 1899 |
| West Roxbury pumping station, used under an agreement made with City of Boston, | Jan. 31, 1899. |
| Spot Pond, improvement begun, | April 10, 1899. |
| Sudbury Reservoir, Marlborough Brook filter-beds first used, | June 1899. |
| Nahant, supplied with water, | June 29, 1899. |
| Swampscott, supplied with water, | June 29, 1899. |
| Arlington, supplied with water, | June 30, 1899. |
| Fells Reservoir, placed in service, | Aug. 31, 1899. |
| Clinton sewerage system, first operated, | Sept. 15, 1899. |
| Spot Pond pumping station, engine moved from Mystic station first operated, | Mar. 7, 1900. |
| Chestnut Hill low-service pumping station, first engine operated, | June 1, 1900. |
| Spot Pond, refilling with water begun, | July 12, 1900. |
| Forbes Hill Reservoir and foundation for standpipe, in Quincy, construction begun, | July 16, 1900. |
| Weston Aqueduct, first lands bought, | Sept. 10, 1900. |
| Spot Pond, improvement substantially completed, | Sept. 15, 1900. |
| Wachusett Dam, contract made, | Oct. 1, 1900. |
| Boston low-service district, supplied with additional pressure, | Oct. 7, 1900. |
| Waban Hill Reservoir, purchased from City of Newton, | Oct. 12, 1900. |
| Boston Water Works, settlement for taking made, | Nov. 1, 1900. |
| Spot Pond pumping station, new engine first operated, | Nov. 1, 1900. |
| Forbes Hill Standpipe, first placed in service, | Dec. 31, 1900. |
| Spot Pond pumping station, completed, | Feb. 9, 1901. |
| Metropolitan Water and Sewerage Board, established by Legislature, | Mar. 20, 1901. |
| Chestnut Hill low-service pumping station, completed, | April 3, 1901. |
| Weston Aqueduct, first contracts for construction made, | May 9, 1901. |
| Stoneham, admitted into Metropolitan Water District, | May 23, 1901. |
| Wachusett Dam, first stone laid, | June 5, 1901. |
| Metropolitan Water District, method of assessment changed, | June 13, 1901. |

| | | | |
|---|---|---|---|
| Bear Hill Reservoir, construction begun, | July | 27, | 1901. |
| Lake Cochituate, improvement of Snake Brook Meadow begun, | Aug. | 21, | 1901. |
| Forbes Hill Reservoir, first filled with water, | Sept. | 27, | 1901. |
| Lake Cochituate, improvement of Pegan Meadow begun, | Sept. | 28, | 1901. |
| Stoneham, supplied with water, | Oct. | 21, | 1901. |
| Lake Cochituate, improvement of Snake Brook Meadow completed, | Jan. | 22, | 1902. |
| Milton, supplied with water, | Feb. | 28, | 1902. |
| Weston Aqueduct, construction of reservoir begun, | April | 1, | 1902. |
| Relocation of Central Massachusetts R.R., agreement with Boston & Maine R.R. made, | April | 3, | 1902. |
| Measuring water supplied to cities and towns, Act passed, | May | 13, | 1902. |
| Bear Hill Reservoir, first filled with water, | June | 22, | 1902. |
| Relocation of Central Massachusetts R.R., contract for viaduct over Nashua River made, | July | 23, | 1902. |
| Wachusett Aqueduct, water first introduced from Wachusett Reservoir, | Nov. | 20, | 1902. |
| Lake Cochituate, improvement of Pegan Meadow completed, | Dec. | 20, | 1902. |
| Spot Pond Brook, report on improvement made to Legislature, | Jan. | 15, | 1903. |
| Lexington, supplied with water, | Jan. | 24, | 1903. |
| Lexington, admitted into Metropolitan Water District, | Feb. | 13, | 1903. |
| Milton, admitted into Metropolitan Water District, | Mar. | 10, | 1903. |
| Relocation of Central Massachusetts R.R., new road bed first used, | June | 15, | 1903. |
| Venturi meters for measurement of water supplied to cities and towns, installed, | June | 27, | 1903. |
| Weston Aqueduct, Pipe Arch Bridge over Sudbury River completed, | Oct. | 19, | 1903. |
| Weston Aqueduct, water first introduced, | Dec. | 29, | 1903. |
| Report on Consumption and Waste of Water made to Legislature, | Feb. | 11, | 1904. |
| Spot Pond Brook, Act for improvement passed, | June | 3, | 1904. |
| Metropolitan Water District, method of assessment changed, | June | 4, | 1904. |
| Wachusett Reservoir, North Dike completed, | Nov. | 18, | 1904. |
| Wachusett Dam, Lower Gate Chamber completed, | Dec. | 22, | 1904. |
| Wachusett Reservoir, Worcester Street embankment and arch bridge completed, | Dec. | 24, | 1904. |
| Wachusett Dam, last stone laid, | July | 22, | 1905. |
| Wachusett Reservoir, South Dike completed, | Sept. | 30, | 1905. |
| Wachusett Dam, contract work completed, | Feb. | 27, | 1906. |
| Metropolitan Water District, method of assessment changed, | June | 6, | 1906. |
| Spot Pond, settlement for taking made, | July | 9, | 1906. |
| Wachusett Reservoir, Sterling filter-beds put into operation, | May | 23, | 1907. |
| Metropolitan Water District, installation of service meters required, | June | 15, | 1907. |
| Arlington pumping station, completed, | July | 19, | 1907. |

| | |
|---|---|
| Wachusett Reservoir, Sterling Junction filter-beds put into operation, | Sept. 16, 1907. |
| Arlington pumping station, new engine placed in service, | Dec. 4, 1907. |
| Wachusett Reservoir, first filled to high-water mark, | May 10, 1908. |
| New 48-inch main from Chestnut Hill Reservoir for Boston low service begun, | Sept. 16, 1908. |
| Swampscott, admitted into Metropolitan Water District, | May 3, 1909. |
| New 48-inch main from Chestnut Hill Reservoir for Boston low service completed, | July 10, 1909. |
| 60-inch main from Weston Aqueduct terminus into Metropolitan District begun, | Aug. 26, 1909. |
| Chestnut Hill low-service pumping station, contract for new engine for high service made, | Sept. 21, 1909. |

# APPENDIX No. 2.

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CONTRACTS MADE AND PENDING DURING

[NOTE. — The details of contracts made before

| | 1. Number of Contract. | 2. WORK. | 3. Number of Bids. | AMOUNT OF BID. | | 6. Contractor. |
|---|---|---|---|---|---|---|
| | | | | 4. Next to Lowest. | 5. Lowest. | |
| 1 | 299[1] | 4,160 tons cast-iron water pipes; 4,100 tons 48-inch, 60 tons 36-inch; 130 tons special castings. | 3 | $103,831 60 | $99,164 00[2] | Warren Foundry and Machine Co., Phillipsburg, N. J. |
| 2 | 300[1] | 36 water valves; 8 36-inch, 4 24-inch, 2 20-inch, 22 12-inch. | 4 | 11,108 00 | 9,750 00[2] | Coffin Valve Co., Boston. |
| 3 | 301[1] | 18 water valves; 10 36-inch, 8 12-inch. | 3 | 7,240 00 | 7,124 00[2] | Coffin Valve Co., Boston. |
| 4 | 302 | 4,000 tons 60-inch cast-iron water pipes. | 1 | - | 98,800 00[2,3] | United States Cast Iron Pipe and Foundry Co., New York, N. Y. |
| 5 | 303[1] | 2,270 tons cast-iron water pipes; 1,530 tons 24-inch, 630 tons 16-inch, 100 tons 12 inch, 10 tons 6-inch; 50 tons special castings. | 4 | 55,618 00 | 54,018 00[2] | Standard Cast Iron Pipe and Foundry Co., Bristol, Pa. |
| 6 | 304[1] | Laying water pipes in Boston and Brookline, Sect. 31 of the distribution system. | 11 | 36,157 50[2] | 32,791 00 | Bruno & Petitti, Boston. |
| 7 | 305 | 4,000 tons, 60-inch cast-iron water pipes. | 1 | - | 98,800 00[2,3] | Florence Iron Works, Camden, N. J. |
| 8 | 306 | 200 tons special castings. | 2 | 14,640 00 | 9,400 00[2] | Standard Cast Iron Pipe and Foundry Co., Bristol, Pa. |
| 9 | 307[1] | Laying 3,900 feet of 16-inch water pipes in Revere, Sect. 32 of the distribution system. | 10 | 3,298 00 | 3,111 50[2] | Camoia & Williams, Boston. |
| 10 | 308 | Laying 12,300 feet of 24-inch water pipes in Everett, Chelsea and Revere, Sect. 33 of the distribution system. | 9 | 14,212 00 | 13,197 50[2] | Camoia & Williams, Boston. |
| 11 | 309[1] | Laying 1,600 feet of 12-inch water pipes in Arlington, Sect. 34 of the distribution system. | 15 | 2,041 40 | 1,884 40[2] | Angelo De Marco & Co., Boston. |

[1] Contract completed.

[2] Contract based upon this bid.

## APPENDIX No. 2.

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THE YEAR 1909 — WATER WORKS.

1909 have been given in previous reports.]

| 7.<br>Date of Contract. | 8.<br>Date of Completion of Work. | 9.<br>Prices of Principal Items of Contracts made in 1909. | 10.<br>Value of Work done December 31, 1909. | |
|---|---|---|---|---|
| Aug. 1, '08, | Aug. 4, '09, | - - | $101,990 55 | 1 |
| May 21, '09, | Nov. 15, '09, | 36-inch valves $755; 24-inch valves $270; 20-inch valves $215; 12-inch valves $100. | 9,750 00 | 2 |
| Aug. 26, '08, | Feb. 17, '09, | - - | 7,198 00 | 3 |
| May 14, '09, | - | 60-inch pipe $24.70 per ton of 2,000 pounds. | 73,013 00 | 4 |
| May 7, '09, | Nov. 16, '09, | 24-inch pipe $22.65; 16-inch pipe $22.95; 12-inch pipe $23.20; 6-inch pipe $23.50; special castings $47 per ton of 2,000 pounds. | 55,984 50 | 5 |
| Sept. 5, '08, | July 22, '09, | - - | 38,909 55 | 6 |
| May 14, '09, | - | 60-inch pipe $24.70 per ton of 2,000 pounds. | 50,684 00 | 7 |
| May 14, '09, | - | Special castings $47 per ton of 2,000 pounds. | 4,840 00 | 8 |
| July 16, '09, | Sept. 21, '09, | For laying 16-inch cast-iron pipe, $0.72 per lin. ft.; for chambers for blow-offs and air valves $75 each. | 3,431 99 | 9 |
| July 16, '09, | - | For laying cast-iron pipe: 24-inch, $0.90 per lin. ft.; 12-inch, 16-inch and 20-inch for connections, $0.50 per lin. ft.; for rock excavation above regular grade, $4 per cu. yd.; for chambers for 20-inch and 24-inch valves, $90 each; for chambers for 16-inch valves and smaller $75 each. | 14,921 27 | 10 |
| Aug. 12, '09, | Oct. 26, '09, | For laying 12-inch cast-iron pipe, $0.53 per lin. ft.; for rock excavation, $3.49 per cu. yd. | 1,823 56 | 11 |

[3] Joint bid for 8,000 tons was made for contracts Nos. 302 and 305.

### CONTRACTS MADE AND PENDING DURING THE

|  | 1. Number of Contract. | 2. WORK. | 3. Number of Bids. | AMOUNT OF BID. 4. Next to Lowest. | AMOUNT OF BID. 5. Lowest. | 6. Contractor. |
|---|---|---|---|---|---|---|
| 1 | 310 | Laying 8,070 feet of 60-inch water pipes in Boston and Newton, Sect. 8 of the supply pipe lines. | 10 | $37,044 50 | $34,908 60[2] | Charles J. Jacobs Co., Boston. |
| 2 | 311[1] | 60-inch Venturi meter tube. | –[4] | –[4] | –[4] | Builders Iron Foundry, Providence, R. I. |
| 3 | 312 | 40,000,000-gallon pumping engine. | 4 | 106,700 00 | 99,769 00[2] | Holly Mfg. Co., Buffalo, N. Y. |
| 4 | 11-M.[1] | 6,000 tons Vulcan coal for Chestnut Hill Pumping Station. | 10 | $3.85 per ton. | $3.75[2] and $3.85 per ton. | Spring Coal Co., Boston. |
| 5 | 12-M.[1] | 1,300 tons Davis coal; 900 tons for Spot Pond Pumping Station, 400 tons for Arlington Pumping Station. | 6 | $4.50 and $4.10 per ton. | $4.19[2] and $3.95 per ton. | Davis Coal and Coke Co., Boston. |
| 6 | 14-M.[1] | 60-inch vertical fire tube boiler for West Roxbury Pumping Station. | 2 | $890 00 | $737 00[2] | Hodge Boiler Works, East Boston. |
| 7 | 15-M.[1] | Addition to West Roxbury Pumping Station. | 2 | 1,727 17 | 1,720 00[2] | John A. Rooney, Boston. |
| 8 | 16-M. | 650 tons Davis coal; 250 tons for Arlington Pumping Station; 400 tons for Spot Pond Pumping Station. | 4 | $3.88 and $4.35 per ton. | $3.70[2] and $4.20 per ton. | New England Coal and Coke Co., Boston. |
| 9 | 17-M. | 7,500 tons Vulcan coal for the Chestnut Hill Pumping Stations. | 10 | $3.70 per ton. | $3.59[2] per ton. | Spring Coal Co., Boston. |
| 10 | 18-M.[1] | 355 tons cast-iron water pipes, 30 tons special castings. | 4 | $10,363 42 | $10,248 50[2] | Warren Foundry and Machine Co., Phillipsburg, N. J. |

[1] Contract completed.

[2] Contract based upon this bid.

YEAR 1909 — WATER WORKS — *Continued.*

| 7. Date of Contract. | 8. Date of Completion of Work. | 9. Prices of Principal Items of Contracts made in 1909. | 10. Value of Work done December 31, 1909. | |
|---|---|---|---|---|
| Aug. 18, '09, | - | For laying 60-inch cast-iron pipe, $3.03 per lin. ft.; for rock excavation above regular grade, $3.15 per cu. yd.; for chambers, for blow-offs and by-pass valves, $100 each; for concrete masonry, $5 per cu. yd. | $25,902 53 | 1 |
| June 21, '09, | Oct. 26, '09, | For whole work $2,350. | 2,350 00 | 2 |
| Sept. 21, '09, | - | For whole work $99,769. | - | 3 |
| July 1, '08, | July 2, '09, | - - | 12,994 31 | 4 |
| July 13, '08, | July 9, '09, | - - | 1,473 36 | 5 |
| Apr. 22, '09, | July 13, '09, | For whole work $737. | 737 00 | 6 |
| May 4, '09, | Sept. 21, '09, | For whole work $1,720. | 1,720 00 | 7 |
| June 18, '09, | - | $3.70 per ton of 2,240 pounds delivered on cars at the Arlington Pumping Station; $4.20 per ton of 2,240 pounds delivered in bins at the Spot Pond Pumping Station. | 2,231 95 | 8 |
| July 16, '09, | - | $3.59 per ton of 2,240 pounds delivered on cars at the Chestnut Hill Pumping Stations. | 12,919 87 | 9 |
| Oct. 18, '09, | Dec. 3, '09, | 48-inch cast-iron pipes $25 per ton of 2,000 pounds; special castings $50 per ton of 2,000 pounds. | 11,756 39 | 10 |

---

[4] Competitive bids were not received.

## CONTRACTS MADE AND PENDING DURING THE YEAR 1909 — WATER WORKS — *Concluded.*

### Summary of Contracts.[1]

| | Value of Work done December 31, 1909. |
|---|---|
| Distribution Department, 14 contracts, . . . . . . . . . . | $390,797 95 |
| 293 contracts completed from 1896 to 1908, inclusive, . . . . . . . . | 15,838,951 22 |
| | $16,229,749 17 |
| Deduct for work done on 11 Sudbury Reservoir contracts by the City of Boston, . | 512,000 00 |
| Total of 318 contracts, . . . . . . . . . . . . . | $15,717,749 17 |

[1] In this summary, contracts charged to maintenance are excluded.

# APPENDIX NO. 3.

## CEMENT TESTS — METROPOLITAN WATER WORKS.

The following tables contain: —

1. Long-time tests of cements used on construction work by the Dam and Aqueduct and Reservoir departments, from 1896 to 1900, inclusive.

2. Tests of cements used in the construction of the Wachusett Dam and other works at the Wachusett Reservoir, from 1901 to 1907, inclusive.

3. Tests of cements used in the construction of distributing works, from 1896 to 1909, inclusive.

The methods of testing were the same as described in Appendix No. 3 of the annual report for the year 1897.

*Summary of Long-time Tests of All Brands of Portland Cement, of which Nine Hundred Barrels or More were used on Construction Work by the Dam and Aqueduct and Reservoir Departments, from 1896 to 1900, inclusive.*

| | BRAND. | Number of Barrels used. | Composition of Briquette. | TENSILE STRENGTH. | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | ONE AND ONE-HALF YEARS. | | TWO YEARS. | | THREE YEARS. | | FIVE YEARS. | | SEVEN AND ONE-HALF YEARS. | | TEN YEARS. | | |
| | | | | Number of Briquettes. | Pounds per Square Inch. | Number of Briquettes. | Pounds per Square Inch. | Number of Briquettes. | Pounds per Square Inch. | Number of Briquettes. | Pounds per Square Inch. | Number of Briquettes. | Pounds per Square Inch. | Number of Briquettes. | Pounds per Square Inch. | |
| 1 | Atlas, . . . . . . | 18,509 | Neat, | 65 | 848 | 80 | 813 | 64 | 814 | 38 | 794 | 39 | 837 | 28 | 771 | 1 |
| | | | 2 to 1, | 65 | 324 | 80 | 325 | 64 | 336 | 38 | 307 | 38 | 319 | 27 | 278 | |
| 2 | Brooks-Shoobridge, (Anchor), | 5,706 | Neat, | 5 | 674 | 55 | 702 | 58 | 696 | 30 | 698 | 17 | 694 | 14 | 704 | 2 |
| | | | 2 to 1, | 5 | 521 | 55 | 447 | 58 | 449 | 30 | 443 | 17 | 417 | 15 | 426 | |
| 3 | Giant, . . . . . . | 15,394 | Neat, | 55 | 598 | 55 | 622 | 45 | 618 | 24 | 633 | 22 | 605 | 15 | 592 | 3 |
| | | | 2 to 1, | 55 | 426 | 55 | 422 | 45 | 414 | 24 | 401 | 22 | 382 | 15 | 356 | |
| 4 | Iron Clad, . . . . . | 7,778 | Neat, | 34 | 769 | 34 | 800 | 26 | 826 | 18 | 838 | 13 | 832 | 11 | 724 | 4 |
| | | | 2 to 1, | 34 | 396 | 34 | 394 | 26 | 378 | 18 | 369 | 12 | 358 | 11 | 306 | |
| 5 | Stettin-Girstow, . . . . | 979 | Neat, | 8 | 665 | 51 | 714 | 42 | 709 | 22 | 695 | 10 | 684 | 10 | 672 | 5 |
| | | | 2 to 1, | 8 | 370 | 53 | 340 | 42 | 382 | 21 | 300 | 10 | 363 | 10 | 285 | |
| 6 | West Kent, . . . . . | 3,394 | Neat, | 19 | 586 | 59 | 589 | 51 | 570 | 29 | 562 | 17 | 548 | 14 | 559 | 6 |
| | | | 2 to 1, | 19 | 522 | 59 | 434 | 51 | 424 | 26 | 391 | 17 | 409 | 14 | 387 | |
| | Total, . . . . . | 51,760 | Neat, | 186 | 721 | 334 | 707 | 281 | 701 | 161 | 702 | 118 | 718 | 92 | 688 | |
| | | | 2 to 1, | 186 | 395 | 336 | 389 | 281 | 389 | 157 | 365 | 116 | 366 | 92 | 335 | |

The results of short-time tests of these cements were published in the sixth annual report of the Board, for the year 1900.

*Summary of Long-time Tests of All Brands of Natural Cement, of which Nine Hundred Barrels or More were used on Construction Work by the Dam and Aqueduct and Reservoir Departments, from 1896 to 1900, inclusive.*

|  | BRAND. | Number of Barrels used. | Composition of Briquette. | TENSILE STRENGTH. |  |  |  |  |  |  |  |  |  |  |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  |  |  |  | TWO YEARS. |  | THREE YEARS. |  | FIVE YEARS. |  | SEVEN AND ONE-HALF YEARS. |  | TEN YEARS. |  |  |
|  |  |  |  | Number of Briquettes. | Pounds per Square Inch. | Number of Briquettes. | Pounds per Square Inch. | Number of Briquettes. | Pounds per Square Inch. | Number of Briquettes. | Pounds per Square Inch. | Number of Briquettes. | Pounds per Square Inch. |  |
| 1 | Beach, . . . . . . | 8,380 | Neat, | 64 | 467 | 50 | 482 | 23 | 506 | 12 | 460 | 7 | 407 | 1 |
|  |  |  | 1 to 1, | 64 | 316 | 50 | 349 | 24 | 369 | 12 | 418 | 7 | 355 |  |
| 2 | Hoffman, . . . . . . | 45,345 | Neat, | 106 | 467 | 91 | 495 | 51 | 514 | 30 | 478 | 23 | 481 | 2 |
|  |  |  | 1 to 1, | 106 | 327 | 91 | 347 | 51 | 364 | 30 | 397 | 23 | 415 |  |
| 3 | Norton, . . . . . . | 60,877 | Neat, | 60 | 440 | 54 | 456 | 28 | 479 | 19 | 407 | 15 | 409 | 3 |
|  |  |  | 1 to 1, | 60 | 295 | 54 | 314 | 27 | 325 | 16 | 328 | 15 | 362 |  |
| 4 | Union, . . . . . . | 900 | Neat, | 22 | 409 | 10 | 474 | 4 | 476 | 3 | 485 | 3 | 538 | 4 |
|  |  |  | 1 to 1, | 22 | 570 | 10 | 617 | 4 | 576 | 3 | 551 | 3 | 618 |  |
|  | Total, . . . . . . | 115,502 | Neat, | 252 | 456 | 205 | 480 | 106 | 501 | 64 | 454 | 48 | 452 |  |
|  |  |  | 1 to 1, | 252 | 388 | 205 | 352 | 106 | 363 | 61 | 391 | 48 | 402 |  |

The results of short-time tests of these cements were published in the sixth annual report of the Board, for the year 1900.

*Summary of Tests of Cements used in the Construction of the Wachusett Dam and Other Works at the Wachusett Reservoir, 1901 to 1907, inclusive.*

| | BRAND. | Number of Barrels used. | | Composition of Briquette. | Fineness. | | | Wire Tests. | | Tensile Strength. | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | At Dam. | Totals. | | Per Cent. Residue on No. 50 Sieve, 2,500 Meshes to Square Inch. | Per Cent. Residue on No. 100 Sieve, 10,000 Meshes to Square Inch. | Per Cent. Residue on No. 180 Sieve, 32,400 Meshes to Square Inch. | Minutes to Bear Light Wire. | Minutes to Bear Heavy Wire. | One Day. | | Seven Days. | | Twenty-eight Days. | | Three Months. | | Six Months. | | |
| | | | | | | | | | | Number of Briquettes. | Pounds per Square Inch. | Number of Briquettes. | Pounds per Square Inch. | Number of Briquettes. | Pounds per Square Inch. | Number of Briquettes. | Pounds per Square Inch. | Number of Briquettes. | Pounds per Square Inch. | |
| | Portland cement: — | | | | | | | | | | | | | | | | | | | |
| 1 | Alpha, | 150 | 491 | Neat, | .4 | 10.9 | 28.6 | 158 | 347 | 47 | 694 | 47 | 1,021 | 5 | 1,026 | 5 | 1,029 | 5 | 1,001 | 1 |
| | | | | 2 to 1, | – | – | – | – | 316 | – | – | 47 | 474 | 5 | 428 | 5 | 445 | 5 | 405 | |
| 2 | Alsen, | 225 | 355 | Neat, | .4 | 11.2 | 26.4 | 116 | 291 | 31 | 625 | 32 | 776 | 15 | 753 | 5 | 761 | 5 | 834 | 2 |
| | | | | 2 to 1, | – | – | – | – | 306 | – | – | 32 | 373 | 15 | 433 | 5 | 413 | 5 | 447 | |
| 3 | Atlas, | 3,094 | 3,793 | Neat, | .2 | 9.0 | 22.4 | 113 | 354 | 207 | 571 | 206 | 837 | 167 | 848 | 20 | 801 | 20 | 848 | 3 |
| | | | | 2 to 1, | – | – | – | – | 287 | – | – | 207 | 384 | 167 | 450 | 20 | 444 | 20 | 445 | |
| 4 | Catskill, | – | 305 | Neat, | .4 | 7.0 | 22.3 | 130 | 300 | 10 | 476 | 10 | 855 | 10 | 903 | – | – | – | – | 4 |
| | | | | 2 to 1, | – | – | – | – | 298 | – | – | 10 | 393 | 10 | 477 | – | – | – | – | |
| 5 | Giant, | 65,809 | 70,786 | Neat, | .5 | 8.7 | 21.9 | 141 | 380 | 4,097 | 586 | 4,032 | 848 | 3,814 | 873 | 381 | 819 | 342 | 863 | 5 |
| | | | | 2 to 1, | – | – | – | – | 383 | – | – | 4,098 | 400 | 3,820 | 451 | 405 | 462 | 345 | 459 | |
| 6 | Helderberg, | 200 | 212 | Neat, | .2 | 5.0 | 19.9 | 173 | 480 | 23 | 383 | 23 | 843 | 23 | 933 | 5 | 906 | 5 | 881 | 6 |
| | | | | 2 to 1, | – | – | – | – | 450 | – | – | 23 | 301 | 23 | 409 | 5 | 377 | 5 | 380 | |
| 7 | Iron Clad, | 4,260 | 4,540 | Neat, | .1 | 4.2 | 17.1 | 86 | 304 | 222 | 652 | 218 | 700 | 221 | 712 | 25 | 714 | 25 | 788 | 7 |
| | | | | 2 to 1, | – | – | – | – | 293 | – | – | 218 | 403 | 222 | 451 | 25 | 474 | 25 | 486 | |
| 8 | Lehigh, | 8,074 | 14,926 | Neat, | .1 | 8.2 | 22.0 | 220 | 484 | 983 | 526 | 982 | 866 | 629 | 874 | 70 | 862 | 65 | 907 | 8 |
| | | | | 2 to 1, | – | – | – | – | 481 | – | – | 982 | 394 | 629 | 496 | 70 | 450 | 65 | 462 | |
| 9 | Star, | – | 1,223 | Neat, | .5 | 9.8 | 24.4 | 147 | 335 | 51 | 691 | 54 | 898 | 31 | 883 | – | – | – | – | 9 |
| | | | | 2 to 1, | – | – | – | – | 356 | – | – | 55 | 415 | 32 | 417 | – | – | – | – | |
| 10 | Stettin-Girstow, | – | 2,200 | Neat, | .7 | 8.3 | 21.3 | 62 | 178 | 252 | 377 | 251 | 475 | 251 | 538 | 15 | 597 | 15 | 664 | 10 |
| | | | | 2 to 1, | – | – | – | – | 351 | – | – | 250 | 281 | 252 | 378 | 15 | 448 | 15 | 496 | |
| 11 | Whitehall, | 150 | 150 | Neat, | .3 | 8.3 | 27.5 | 180 | 360 | 20 | 736 | 20 | 946 | 13 | 970 | 5 | 996 | 5 | 971 | 11 |
| | | | | 2 to 1, | – | – | – | – | 450 | – | – | 20 | 434 | 13 | 478 | 5 | 474 | 5 | 445 | |
| | Total, | 81,962 | 98,981 | Neat, | .4 | 8.4 | 21.8 | 144 | 381 | 5,943 | 570 | 5,875 | 831 | 5,179 | 850 | 531 | 817 | 487 | 862 | |
| | | | | 2 to 1, | – | – | – | – | 385 | – | – | 5,942 | 394 | 5,188 | 452 | 555 | 458 | 490 | 459 | |
| | Natural cement: — | | | | | | | | | | | | | | | | | | | |
| 12 | Union, | 182,480 | 182,480 | Neat, | .9 | 6.2 | 13.6 | 65 | 131 | 7,070 | 173 | 7,065 | 222 | 2,925 | 293 | 430 | 351 | 430 | 391 | 12 |
| | | | | 1 to 1, | – | – | – | 56 | 110 | – | – | 7,042 | 183 | 2,918 | 273 | 425 | 398 | 425 | 469 | |
| | | | | 2 to 1, | – | – | – | – | – | – | – | 1,399 | 116 | 1,387 | 197 | 355 | 287 | 340 | 375 | |

*Summary of Tests of Cements used in the Construction of the Wachusett Dam and Other Works at the Wachusett Reservoir, 1901 to 1907, inclusive* — Concluded.

| | BRAND. | NUMBER OF BARRELS USED. | | Composition of Briquette. | TENSILE STRENGTH — *Concluded.* | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | NINE MONTHS. | | ONE YEAR. | | ONE AND ONE-HALF YEARS. | | TWO YEARS. | | THREE YEARS. | | FIVE YEARS. | | SEVEN AND ONE-HALF YEARS. | | |
| | | At Dam. | Totals. | | Number of Briquettes. | Pounds per Square Inch. | Number of Briquettes. | Pounds per Square Inch. | Number of Briquettes. | Pounds per Square Inch. | Number of Briquettes. | Pounds per Square Inch. | Number of Briquettes. | Pounds per Square Inch. | Number of Briquettes. | Pounds per Square Inch. | Number of Briquettes. | Pounds per Square Inch. | |
| | Portland cement: — | | | | | | | | | | | | | | | | | | |
| 1 | Alpha, . . . | 150 | 491 | Neat, . | 5 | 1,063 | 5 | 1,015 | 5 | 1,029 | 5 | 1,034 | 5 | 847 | 5 | 906 | - | - | 1 |
| | | | | 2 to 1, . | 5 | 452 | 5 | 406 | 5 | 340 | 5 | 320 | 5 | 310 | 4 | 238 | - | - | |
| 2 | Alsen, . . . | 225 | 355 | Neat, . | 5 | 723 | 5 | 813 | 5 | 825 | 5 | 824 | 5 | 788 | 5 | 800 | - | - | 2 |
| | | | | 2 to 1, . | 5 | 380 | 5 | 393 | 5 | 381 | 5 | 382 | 5 | 335 | 2 | 289 | - | - | |
| 3 | Atlas, . . . | 3,094 | 3,793 | Neat, . | 20 | 823 | 20 | 899 | 20 | 873 | 20 | 842 | 19 | 846 | 20 | 851 | - | - | 3 |
| | | | | 2 to 1, . | 20 | 459 | 20 | 422 | 20 | 404 | 20 | 365 | 20 | 352 | 17 | 333 | - | - | |
| 5 | Giant, . . . | 65,809 | 70,786 | Neat, . | 355 | 851 | 335 | 848 | 335 | 853 | 335 | 845 | 334 | 846 | 306 | 851 | 110 | 879 | 5 |
| | | | | 2 to 1, . | 334 | 453 | 330 | 433 | 334 | 402 | 330 | 396 | 329 | 371 | 300 | 355 | 109 | 318 | |
| 6 | Helderberg, . . | 200 | 212 | Neat, . | 5 | 872 | 5 | 897 | 5 | 870 | 5 | 896 | 5 | 783 | 5 | 845 | - | - | 6 |
| | | | | 2 to 1, . | 5 | 402 | 5 | 386 | 5 | 389 | 5 | 372 | 5 | 325 | 5 | 338 | - | - | |
| 7 | Iron Clad, . . | 4,260 | 4,540 | Neat, . | 25 | 769 | 25 | 807 | 25 | 885 | 25 | 851 | 25 | 806 | 25 | 821 | 10 | 736 | 7 |
| | | | | 2 to 1, . | 25 | 497 | 25 | 488 | 25 | 505 | 25 | 504 | 25 | 438 | 24 | 422 | 10 | 469 | |
| 8 | Lehigh, . . . | 8,074 | 14,926 | Neat, . | 64 | 898 | 70 | 903 | 70 | 932 | 70 | 951 | 70 | 869 | 60 | 854 | - | - | 8 |
| | | | | 2 to 1, . | 65 | 430 | 70 | 445 | 70 | 407 | 70 | 395 | 70 | 371 | 56 | 348 | - | - | |
| 10 | Stettin-Girstow, . | - | 2,200 | Neat, . | 15 | 692 | 15 | 709 | 15 | 728 | 15 | 667 | 15 | 749 | 15 | 687 | - | - | 10 |
| | | | | 2 to 1, . | 15 | 486 | 15 | 486 | 15 | 481 | 15 | 434 | 15 | 517 | 15 | 481 | - | - | |
| 11 | Whitehall, . . | 150 | 150 | Neat, . | 5 | 874 | 5 | 1,047 | - | - | 5 | 839 | 5 | 930 | 7 | 813 | 2 | 755 | 11 |
| | | | | 2 to 1, . | 5 | 431 | 5 | 352 | - | - | 5 | 388 | 5 | 374 | 7 | 333 | 2 | 265 | |
| | Total, . . . | 81,962 | 98,981 | Neat, . | 499 | 848 | 485 | 855 | 480 | 865 | 485 | 857 | 483 | 844 | 448 | 844 | 122 | 865 | |
| | | | | 2 to 1, . | 479 | 452 | 480 | 437 | 479 | 409 | 480 | 400 | 479 | 377 | 430 | 359 | 121 | 330 | |
| | Natural cement: — | | | | | | | | | | | | | | | | | | |
| 12 | Union, . . . | 182,480 | 182,480 | Neat, . | - | - | 409 | 420 | - | - | 401 | 464 | 410 | 467 | 357 | 452 | 98 | 459 | 12 |
| | | | | 1 to 1, . | - | - | 409 | 522 | - | - | 410 | 581 | 410 | 585 | 360 | 586 | 100 | 617 | |
| | | | | 2 to 1, . | - | - | 345 | 416 | - | - | 338 | 447 | 344 | 439 | 294 | 433 | 40 | 444 | |

*Summary of Tests of Cements used in the Construction of Distributing Works, from 1896 to 1909, inclusive.*

|  | BRAND. | Number of Barrels used. | Composition of Briquette. | FINENESS. |  |  | WIRE TESTS. |  | TENSILE STRENGTH. |  |  |  |  |  |  |  |  |  |  |  |  |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  |  |  |  | Per Cent. Residue on No. 50 Sieve, 2,500 Meshes to Square Inch. | Per Cent. Residue on No. 100 Sieve, 10,000 Meshes to Square Inch. | Per Cent. Residue on No. 180 Sieve, 32,400 Meshes to Square Inch. | Minutes to bear Light Wire. | Minutes to bear Heavy Wire. | ONE DAY. Number of Briquettes. | ONE DAY. Pounds per Square Inch. | SEVEN DAYS. Number of Briquettes. | SEVEN DAYS. Pounds per Square Inch. | TWENTY-EIGHT DAYS. Number of Briquettes. | TWENTY-EIGHT DAYS. Pounds per Square Inch. | THREE MONTHS. Number of Briquettes. | THREE MONTHS. Pounds per Square Inch. | SIX MONTHS. Number of Briquettes. | SIX MONTHS. Pounds per Square Inch. | NINE MONTHS. Number of Briquettes. | NINE MONTHS. Pounds per Square Inch. |  |
|  | Portland cement: — |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1 | Alpha, . . . | 1,393 | Neat, | .3 | 8.7 | 21.1 | 122 | 315 | 148 | 432 | 73 | 737 | 14 | 793 | 14 | 858 | 14 | 876 | 14 | 866 | 1 |
|  |  |  | 2 to 1, | - | - | - | - | 351 | - | - | 73 | 335 | 16 | 333 | 14 | 367 | 14 | 388 | 14 | 396 |  |
| 2 | Anchor, . . . | 298 | Neat, | 1.4 | 14.7 | 34.0 | 53 | 170 | 19 | 327 | 26 | 470 | - | - | - | - | - | - | - | - | 2 |
|  |  |  | 2 to 1, | - | - | - | - | 238 | - | - | 15 | 202 | - | - | - | - | - | - | - | - |  |
| 3 | Atlas, . . . | 26,703 | Neat, | .1 | 11.3 | 28.3 | 141 | 365 | 2,038 | 530 | 996 | 733 | 20 | 761 | 15 | 858 | 18 | 878 | 15 | 947 | 3 |
|  |  |  | 2 to 1, | - | - | - | 120 | 258 | - | - | 810 | 316 | 28 | 328 | 26 | 396 | 29 | 405 | 20 | 331 |  |
| 4 | Giant, . . . | 900 | Neat, | .0 | 10.0 | - | 191 | 365 | 150 | 381 | - | - | - | - | - | - | - | - | - | - | 4 |
| 5 | Lehigh, . . . | 4,574 | Neat, | .1 | 9.3 | 26.7 | 140 | 362 | 388 | 479 | 370 | 737 | 15 | 864 | 15 | 807 | 15 | 937 | 15 | 952 | 5 |
|  |  |  | 2 to 1, | - | - | - | 60 | 353 | - | - | 356 | 352 | 25 | 387 | 15 | 400 | 15 | 418 | 15 | 418 |  |
| 6 | Saylor, . . . | 300 | Neat, | .0 | 5.5 | 19.0 | 50 | 104 | - | - | 24 | 439 | 6 | 582 | - | - | - | - | - | - | 6 |
|  |  |  | 2 to 1, | - | - | - | 21 | 52 | - | - | 6 | 194 | 6 | 274 | - | - | - | - | - | - |  |
|  | Total, . . . | 34,168 | Neat, | .1 | 10.9 | 27.7 | 140 | 359 | 2,743 | 508 | 1,489 | 725 | 55 | 778 | 44 | 841 | 47 | 896 | 44 | 921 |  |
|  |  |  | 2 to 1, | - | - | - | 110 | 273 | - | - | 1,260 | 325 | 75 | 344 | 55 | 390 | 58 | 404 | 49 | 376 |  |
|  | Natural cement: — |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 7 | Beach, . . . | 400 | Neat, | 5.0 | 17.0 | - | 60 | 130 | 5 | 167 | 5 | 204 | - | - | - | - | - | - | - | - | 7 |
|  |  |  | 1 to 1, | - | - | - | - | - | - | - | 5 | 102 | - | - | - | - | - | - | - | - |  |
| 8 | Connelly & Schaffer, | 878 | Neat, | 8.4 | 22.4 | - | 18 | 41 | 14 | 106 | 10 | 129 | - | - | - | - | - | - | - | - | 8 |
|  |  |  | 1 to 1, | - | - | - | 20 | 38 | - | - | 10 | 75 | - | - | - | - | - | - | - | - |  |
| 9 | Hoffman, . . | 13,984 | Neat, | 4.0 | 15.5 | - | 28 | 57 | 1,415 | 153 | 1,048 | 167 | 10 | 293 | 10 | 392 | 9 | 403 | - | - | 9 |
|  |  |  | 1 to 1, | - | - | - | 26 | 53 | - | - | 956 | 116 | 10 | 228 | 10 | 384 | 10 | 360 | - | - |  |
| 10 | Newark & Rosendale, | 1,562 | Neat, | 3.8 | 16.1 | - | 61 | 118 | 53 | 106 | 21 | 182 | - | - | - | - | 5 | 404 | - | - | 10 |
|  |  |  | 1 to 1, | - | - | - | 15 | 30 | - | - | 21 | 126 | - | - | - | - | - | - | - | - |  |
|  | Total, . . . | 16,824 | Neat, | 4.2 | 16.0 | - | 31 | 64 | 1,487 | 151 | 1,084 | 167 | 10 | 293 | 10 | 392 | 14 | 403 | - | - |  |
|  |  |  | 1 to 1, | - | - | - | 25 | 50 | - | - | 992 | 116 | 10 | 228 | 10 | 384 | 10 | 360 | - | - |  |

*Summary of Tests of Cements used in the Construction of Distributing Works, from 1896 to 1909, inclusive* — Concluded.

|  | BRAND. | Number of Barrels used. | Composition of Briquette. | Tensile Strength — *Concluded.* |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  |  |  |  | ONE YEAR. |  | ONE AND ONE-HALF YEARS. |  | TWO YEARS. |  | THREE YEARS. |  | FIVE YEARS. |  | SEVEN AND ONE-HALF YEARS. |  | TEN YEARS. |  |  |
|  |  |  |  | Number of Briquettes. | Pounds per Square Inch. | Number of Briquettes. | Pounds per Square Inch. | Number of Briquettes. | Pounds per Square Inch. | Number of Briquettes. | Pounds per Square Inch. | Number of Briquettes. | Pounds per Square Inch. | Number of Briquettes. | Pounds per Square Inch. | Number of Briquettes. | Pounds per Square Inch. |  |
|  | Portland Cement: — |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1 | Alpha, . . . . . . | 1,393 | Neat, | 14 | 886 | 14 | 971 | 4 | 965 | 8 | 970 | 8 | 1,024 | 6 | 884 | 4 | 742 | 1 |
|  |  |  | 2 to 1, | 14 | 422 | 14 | 415 | 4 | 366 | 8 | 387 | 8 | 340 | 6 | 296 | 4 | 299 |  |
| 3 | Atlas, . . . . . . | 26,703 | Neat, | 18 | 972 | 15 | 1,021 | 18 | 955 | 9 | 1,010 | 9 | 1,019 | 8 | 862 | 4 | 919 | 3 |
|  |  |  | 2 to 1, | 23 | 341 | 15 | 291 | 21 | 319 | 12 | 334 | 12 | 320 | 7 | 337 | 4 | 295 |  |
| 5 | Lehigh, . . . . . . | 4,574 | Neat, | 15 | 934 | 15 | 962 | 5 | 966 | 9 | 1,017 | 9 | 1,051 | 6 | 935 | 6 | 904 | 5 |
|  |  |  | 2 to 1, | 15 | 424 | 15 | 413 | 5 | 427 | 9 | 373 | 9 | 368 | 5 | 340 | 6 | 314 |  |
|  | Total, . . . . . . | 32,670 | Neat, | 47 | 934 | 44 | 985 | 27 | 959 | 26 | 1,000 | 26 | 1,032 | 20 | 891 | 14 | 862 |  |
|  |  |  | 2 to 1, | 52 | 387 | 44 | 372 | 30 | 343 | 29 | 361 | 29 | 340 | 18 | 324 | 14 | 304 |  |
|  | Natural Cement: — |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 9 | Hoffman, . . . . . . | 13,984 | Neat, | 10 | 453 | - | - | 10 | 468 | 6 | 473 | 6 | 486 | 4 | 530 | 2 | 286 | 9 |
|  |  |  | 1 to 1, | 10 | 341 | - | - | 10 | 348 | 6 | 364 | 6 | 436 | 4 | 466 | 2 | 499 |  |

No long-time tests of brands numbered 2, 4, 6, 7, 8 and 10.

## APPENDIX No. 4.

TABLE No. 1.—*Monthly Rainfall in Inches at Various Places on the Metropolitan Water Works, in 1909.*

| PLACE. | | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. | Totals. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Wachusett Watershed. | Princeton, | 3.29 | 6.03 | 3.94 | 5.61 | 2.94 | 2.74 | 4.06 | 3.39 | 3.46 | 1.72 | 1.59 | 3.84 | 42.61 |
| | Jefferson, | 4.14 | 6.29 | 4.57 | 6.13 | 2.31 | 3.22 | 5.29 | 4.22 | 4.13 | 2.08 | 1.89 | 4.41 | 48.68 |
| | Sterling, | 3.21 | 5.86 | 4.35 | 5.40 | 2.44 | 3.05 | 3.59 | 3.32 | 3.30 | 1.86 | 1.23 | 4.09 | 41.70 |
| | Boylston, | 3.45 | 6.22 | 4.65 | 5.68 | 2.90 | 3.10 | 4.07 | 3.42 | 4.72 | 1.20 | 2.02 | 3.64 | 45.07 |
| Sudbury Watershed. | Sudbury Dam, | 3.92 | 5.63 | 4.18 | 4.60 | 2.32 | 2.60 | 1.77 | 2.82 | 4.92 | 1.01 | 3.41 | 4.04 | 41.22 |
| | Framingham, | 4.14 | 5.77 | 4.07 | 4.53 | 2.31 | 2.89 | 1.63 | 2.82 | 4.55 | 1.09 | 3.24 | 3.94 | 40.98 |
| | Ashland Dam, | 3.98 | 5.75 | 4.30 | 4.59 | 2.34 | 3.21 | 1.94 | 2.74 | 4.59 | 1.13 | 3.38 | 4.01 | 41.96 |
| | Cordaville, | 3.86 | 6.03 | 4.47 | 4.95 | 2.73 | 2.53 | 1.74 | 3.35 | 4.91 | 1.25 | 3.50 | 4.21 | 43.53 |
| Lake Cochituate, | | 4.34 | 5.66 | 3.98 | 4.50 | 2.05 | 3.09 | 1.73 | 2.84 | 4.33 | 1.06 | 3.76 | 4.10 | 41.44 |
| Chestnut Hill Reservoir, | | 4.79 | 5.61 | 4.27 | 4.53 | 2.44 | 4.12 | 1.10 | 4.11 | 5.79 | 1.58 | 4.89 | 4.39 | 47.62 |
| Spot Pond, | | 4.04 | 5.31 | 3.80 | 4.23 | 1.96 | 4.27 | 2.27 | 3.53 | 5.12 | 1.28 | 4.31 | 3.95 | 44.07 |
| Average of all, | | 3.92 | 5.83 | 4.24 | 4.98 | 2.43 | 3.17 | 2.59 | 3.32 | 4.53 | 1.38 | 3.02 | 4.06 | 43.47 |
| Average, Wachusett watershed, | | 3.52 | 6.10 | 4.38 | 5.71 | 2.65 | 3.08 | 4.25 | 3.59 | 3.90 | 1.70 | 1.68 | 3.99 | 44.50 |
| Average, Sudbury watershed, | | 3.98 | 5.79 | 4.26 | 4.67 | 2.43 | 2.81 | 1.59 | 2.93 | 4.74 | 1.12 | 3.38 | 4.05 | 41.75 |

TABLE No. 2. — *Rainfall in Inches at Jefferson, Mass., in 1909.*

| DAY OF MONTH. | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1, . . . . . . | - | - | - | - | 0.28 | - | - | - | 0.21 | - | - | - |
| 2, . . . . . . | - | - | 0.49[3] | [2] | - | - | - | - | - | - | [2] | - |
| 3, . . . . . . | - | - | [2] | 0.21[3] | - | - | 0.17 | - | - | - | 0.27 | - |
| 4, . . . . . . | - | - | 0.27[1] | - | 0.06 | - | - | [2] | - | - | - | - |
| 5, . . . . . . | [2] | - | - | - | - | 1.60 | - | 1.27 | 0.49 | - | - | - |
| 6, . . . . . . | 0.79 | - | - | 0.09 | - | - | 0.23 | - | - | - | - | - |
| 7, . . . . . . | - | - | - | - | - | - | - | - | - | - | - | 0.36 |
| 8, . . . . . . | - | - | - | - | - | - | - | - | - | - | - | - |
| 9, . . . . . . | - | [2] | [2] | - | - | - | - | - | - | - | - | - |
| 10, . . . . . . | 0.12[3] | 1.25[3] | 0.60 | - | - | 0.61 | - | - | 0.67 | - | - | - |
| 11, . . . . . . | - | - | - | - | 0.23 | - | - | - | - | - | - | - |
| 12, . . . . . . | 0.52[1] | - | - | - | - | - | - | - | - | 0.43 | - | - |
| 13, . . . . . . | - | 0.41[3] | - | - | - | 0.10 | - | 0.45 | - | - | - | [2] |
| 14, . . . . . . | 0.30[3] | [2] | 0.07[1] | [2] | - | - | - | - | - | - | - | 1.96[3] |
| 15, . . . . . . | - | [2] | 0.16[1] | 3.30 | - | - | - | - | - | 0.15 | - | - |
| 16, . . . . . . | [2] | 1.24[3] | - | - | 0.34 | - | 2.56 | [2] | - | - | - | - |
| 17, . . . . . . | 1.38[3] | - | - | - | - | [2] | - | [2] | 0.30 | - | 0.33 | - |
| 18, . . . . . . | - | - | - | - | 0.27 | 0.83 | 0.54 | 2.42 | - | - | - | - |
| 19, . . . . . . | - | [2] | [2] | 0.33 | - | - | - | - | - | - | - | - |
| 20, . . . . . . | - | 1.39 | 0.13[1] | - | - | - | - | 0.08 | - | - | - | - |
| 21, . . . . . . | - | - | - | [2] | - | - | - | - | - | [2] | - | - |
| 22, . . . . . . | - | - | - | 0.31 | [2] | 0.08 | 1.04 | - | - | 0.58 | [2] | - |
| 23, . . . . . . | - | [2] | - | 0.58 | 0.65 | - | 0.64 | - | [2] | [2] | [2] | - |
| 24, . . . . . . | [2] | 2.00[3] | - | - | - | - | - | - | 0.65 | 0.87 | [2] | - |
| 25, . . . . . . | 0.62 | - | 2.45 | - | - | - | - | - | - | - | [2] | [2] |
| 26, . . . . . . | - | - | - | - | - | - | - | - | [2] | - | 1.10[3] | 2.09[1] |
| 27, . . . . . . | - | - | - | - | [2] | - | - | - | [2] | - | - | - |
| 28, . . . . . . | - | - | 0.40[3] | 0.84 | [2] | - | - | - | 1.81 | - | - | - |
| 29, . . . . . . | [2] | - | - | [2] | 0.48 | - | - | - | - | - | 0.19 | - |
| 30, . . . . . . | 0.41[1] | - | - | 0.47[3] | - | - | 0.11 | - | - | - | - | - |
| 31, . . . . . . | - | - | - | - | - | - | - | - | - | - | - | - |
| Total, . . . | 4.14 | 6.29 | 4.57 | 6.13 | 2.31 | 3.22 | 5.29 | 4.22 | 4.13 | 2.03 | 1.89 | 4.41 |

**Total for the year 48.68 inches.**

**[1] Snow. [2] Rainfall included in that of following day. [3] Rain and snow.**

TABLE NO. 3. — *Rainfall in Inches at Framingham, Mass., in 1909.*

| Day of Month. | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1, | - | - | [2] | - | 0.30 | - | - | - | 0.21 | - | - | - |
| 2, | - | - | 0.24[3] | [2] | - | - | [2] | - | - | - | [2] | - |
| 3, | - | - | [2] | 0.25 | 0.08 | - | 0.14 | - | - | - | [2] | - |
| 4, | [2] | - | 0.35[3] | - | - | [2] | - | [2] | - | - | 0.61 | - |
| 5, | 0.15 | - | - | - | - | 1.42 | 0.01 | [2] | 0.20 | - | - | - |
| 6, | 0.92 | - | - | 0.01 | - | - | 0.20 | 0.63 | - | - | - | - |
| 7, | - | - | 0.01[1] | - | 0.02 | - | - | - | - | - | - | 0.53 |
| 8, | - | - | - | - | - | - | - | - | - | - | 0.02 | - |
| 9, | - | [2] | [2] | 0.13 | 0.02 | [2] | - | - | - | - | - | - |
| 10, | 0.03 | 1.38[3] | 0.65 | - | [2] | [2] | - | - | [2] | - | - | - |
| 11, | - | 0.01[1] | - | - | 0.42 | 0.42 | - | - | 0.87 | - | - | - |
| 12, | 0.41[3] | [2] | - | - | - | - | - | - | - | 0.07 | - | - |
| 13, | - | 0.03 | [2] | [2] | - | 0.35 | - | 0.04 | - | - | - | [2] |
| 14, | [2] | [2] | 0.03[1] | [2] | - | - | - | - | - | 0.28 | - | 1.35[3] |
| 15, | 0.39[3] | [2] | - | 1.95 | [2] | - | - | [2] | - | 0.05 | - | - |
| 16, | [2] | 1.35[3] | [2] | - | 0.38 | - | 0.30 | 0.13 | 0.02 | - | - | - |
| 17, | 1.08[3] | - | 0.07[3] | - | [2] | [2] | - | [2] | 0.10 | - | 0.09 | - |
| 18, | - | - | - | - | 0.05 | 0.52 | 0.36 | 1.76 | - | 0.01 | - | - |
| 19, | - | [2] | [2] | [2] | - | - | - | - | - | - | - | - |
| 20, | - | 1.10 | 0.17[1] | 0.08 | - | - | - | 0.07 | - | - | - | - |
| 21, | - | - | - | [2] | - | - | - | - | - | 0.36 | - | - |
| 22, | - | - | - | 0.38 | [2] | [2] | 0.02 | - | [2] | - | 0.03 | - |
| 23, | [2] | [2] | - | 0.49 | 0.53 | 0.07 | [2] | - | [2] | [2] | [2] | - |
| 24, | [2] | 1.88 | - | - | - | - | 0.60 | - | 1.63 | 0.28 | [2] | - |
| 25, | 0.59[3] | - | 2.08 | - | - | - | - | - | - | - | [2] | [2] |
| 26, | - | - | - | - | - | - | - | - | [2] | - | 2.27[3] | 2.06[1] |
| 27, | - | [2] | [2] | [2] | [2] | - | - | - | [2] | 0.03 | - | - |
| 28, | - | 0.02[2] | 0.52 | 0.73 | 0.29 | 0.11 | - | - | 1.52 | - | - | - |
| 29, | [2] | - | - | [2] | 0.22 | - | - | 0.19 | - | - | 0.22 | - |
| 30, | 0.57[1] | - | - | 0.51[3] | - | - | - | - | - | - | - | - |
| 31, | - | - | - | - | - | - | - | - | - | 0.01 | - | - |
| Total, | 4.14 | 5.77 | 4.07 | 4.53 | 2.31 | 2.89 | 1.63 | 2.82 | 4.55 | 1.09 | 3.24 | 3.94 |

**Total for the year 40.98 inches.**

[1] Snow.

[2] Rainfall included in that of the following day.

[3] Rain and snow.

TABLE No. 4. — *Rainfall in Inches at Chestnut Hill Reservoir in 1909.*

| DATE. | Amount. | Duration. |
|---|---|---|
| Jan. 3, | .09 | 6.30 P.M. to |
| Jan. 4, | | 6.30 A.M. |
| Jan. 5, | 1.00 | 8.30 A.M. to |
| Jan. 6, | | 7.15 A.M. |
| Jan. 11, | .27 | 6.50 A.M. to |
| Jan. 12, | | 4.15 P.M. |
| Jan. 13, | .06[1] | 10.50 P.M. to |
| Jan. 14, | | 12.30 P.M. |
| Jan. 14, | .46[2] | 1.00 P.M. to |
| Jan. 15, | | 1.30 A.M. |
| Jan. 16, | .91[2] | 7.15 P.M. to |
| Jan. 17, | | 6.00 P.M. |
| Jan. 24, | 1.00 | 7.10 A.M. to |
| Jan. 25, | | 6.00 A.M. |
| Jan. 28, | .09[1] | 5.25 A.M. to 10.00 A.M. |
| Jan. 29, | .91[1] | 10.00 P.M. to |
| Jan. 30, | | 11.00 P.M. |
| Total, | 4.79 | |
| Feb. 9, | 1.47[2] | 10.00 P.M. to |
| Feb. 10, | | 7.00 P.M. |
| Feb. 14, | .54 | 8.00 P.M. to |
| Feb. 15, | | 6.20 A.M. |
| Feb. 15, | .80 | 8.00 A.M. to |
| Feb. 16, | | 11.00 P.M. |
| Feb. 19, | .91 | 2.30 P.M. to |
| Feb. 20, | | 10.00 A.M. |
| Feb. 23, | 1.81 | 8.00 P.M. to |
| Feb. 25, | | 2.10 A.M. |
| Feb. 27, | .08[1] | 11.05 P.M. to |
| Feb. 28, | | 10.00 A.M. |
| Total, | 5.61 | |
| Mar. 1, | .27[2] | 11.50 P.M. to |
| Mar. 2, | | 2.00 P.M. |
| Mar. 3, | .45[2] | 6.00 P.M. to |
| Mar. 4, | | 10.00 A.M. |
| Mar. 9, | .76 | 12.30 P.M. to |
| Mar. 10, | | 5.50 A.M. |
| Mar. 10, | .04 | 8.30 A.M. to 1.30 P.M. |
| Mar. 17, | .09[2] | 12.40 A.M. to 6.10 A.M. |
| Mar. 19, | .23[1] | 8.00 P.M. to |
| Mar. 20, | | 6.25 A.M. |
| Mar. 25, | 1.90 | 7.00 A.M. to 10.40 P.M. |
| Mar. 28, | .53 | 2.35 A.M. to 2.30 P.M. |
| Total, | 4.27 | |
| Apr. 2, | .32 | 11.00 A.M. to |
| Apr. 3, | | 8.30 P.M. |
| Apr. 9, | .18 | 6.35 A.M. to 3.00 P.M. |
| Apr. 14, | 1.60 | 3.15 A.M. to |
| Apr. 15, | | 3.30 P.M. |
| Apr. 19, | .06 | 5.00 P.M. to |
| Apr. 20, | | 5.50 A.M. |
| Apr. 21, | .31 | 7.00 P.M. to |
| Apr. 22, | | 7.30 A.M. |
| Apr. 23, | .53 | 11.15 A.M. to 4.45 P.M. |
| Apr. 27, | .86 | 11.15 P.M. to |
| Apr. 28, | | 9.30 A.M. |
| Apr. 30, | .67 | 2.25 A.M. to |
| May 1, | | 7.00 A.M. |
| Total, | 4.53 | |

| DATE. | Amount. | Duration. |
|---|---|---|
| May 1, | .40 | 7.00 A.M. to 10.30 P.M. |
| May 4, | .18 | 2.15 A.M. to 6.45 A.M. |
| May 5, | .04 | 12.30 A.M. to 3.30 A.M. |
| May 7, | .18 | 12.55 A.M. to 3.25 A.M. |
| May 11, | .09 | 12.55 A.M. to 5.25 A.M. |
| May 16, | .34 | 3.45 A.M. to 9.30 A.M. |
| May 16, | .13 | 5.10 P.M. to |
| May 18, | | 7.30 A.M. |
| May 21, | .63 | 11.30 P.M. to |
| May 23, | | 10.30 A.M. |
| May 27, | .36 | 4.00 P.M. to |
| May 28, | | 5.25 A.M. |
| May 29, | .09 | 2.40 P.M. to 6.30 P.M. |
| Total, | 2.44 | |
| June 5, | 2.08 | 3.40 A.M. to |
| June 6, | | 4.40 A.M. |
| June 10, | .52 | 5.55 A.M. to 11.45 P.M. |
| June 11, | .05 | 10.05 A.M. to 2.25 P.M. |
| June 13, | .89 | 6.40 P.M. to |
| June 14, | | 1.45 A.M. |
| June 17, | .53 | 11.30 P.M. to |
| June 18, | | 7.00 A.M. |
| June 23, | .05 | 12.25 A.M. to 4.30 A.M. |
| Total, | 4.12 | |
| July 1, | .02 | 8.00 P.M. to 8.15 P.M. |
| July 3, | .21 | 2.20 A.M. to 7.30 A.M. |
| July 6, | .05 | 1.00 A.M. to 9.00 P.M. |
| July 16, | .29 | 4.00 P.M. to 10.00 P.M. |
| July 18, | .37 | 7.00 P.M. to 9.00 P.M. |
| July 19, | .06 | 11.15 A.M. to 11.50 A.M. |
| July 23, | .10 | 1.35 P.M. to |
| July 24, | | 2.05 A.M. |
| Total, | 1.10 | |
| Aug. 4, | .95 | 11.15 P.M. to |
| Aug. 6, | | 7.30 A.M. |
| Aug. 16, | .03 | 4.25 A.M. to 5.25 A.M. |
| Aug. 17, | 2.72 | 7.30 A.M. to |
| Aug. 18, | | 6.00 A.M. |
| Aug. 20, | .05 | 7.35 P.M. to 8.50 P.M. |
| Aug. 29, | .36 | 3.10 P.M. to 4.00 P.M. |
| Total, | 4.11 | |
| Sept. 1, | .46 | 2.10 P.M. to 5.15 P.M. |
| Sept. 5, | .21 | 6.50 A.M. to 12.30 P.M. |
| Sept. 10, | 1.08 | 1.45 P.M. to |
| Sept. 11, | | 7.30 A.M. |
| Sept. 17, | .02 | 5.10 A.M. to 5.20 A.M. |
| Sept. 17, | .23 | 7.20 A.M. to 1.15 P.M. |
| Sept. 23, | .91 | 6.30 A.M. to |
| Sept. 24, | | 2.35 A.M. |
| Sept. 24, | .78 | 10.10 A.M. to |
| Sept. 25, | | 2.45 A.M. |
| Sept. 26, | 2.10 | 7.55 A.M. to |
| Sept. 28, | | 10.15 P.M. |
| Total, | 5.79 | |

[1] Snow.

[2] Rain and snow.

TABLE No 4. — *Rainfall in Inches at Chestnut Hill Reservoir in 1909* — Concluded.

| Date. | Amount. | Duration. |
|---|---|---|
| Oct. 12, . . | .17 | 7.05 A.M. to 12.30 P.M. |
| Oct. 15, . . | .21 | 12.25 A.M. to 3.45 A.M. |
| Oct. 15, . . | .10 | 7.55 A.M. to 1.00 P.M. |
| Oct. 18, . . | .04 | 5.00 P.M. to 8.15 P.M. |
| Oct. 21, . . | .58 | 6.00 P.M. to |
| Oct. 22, . . | | 2.40 A.M. |
| Oct. 23, . . | .59 | 9.00 P.M. to |
| Oct. 25, . . | | 3.35 A.M. |
| Oct. 28, . . | .06 | 12.05 A.M. to 2.25 A.M. |
| Total, . | 1.58 | |
| Nov. 2, . . | .69 | 2.25 P.M. to |
| Nov. 4, . . | | 5.45 A.M. |
| Nov. 8, . . | .05 | 2.30 P.M. to 8.00 P.M. |
| Nov. 16, . . | .14 | 6.30 P.M. to |
| Nov. 17, . . | | 3.45 P.M. |
| Nov. 22, . . | .05 | 11.15 A.M. to |
| Nov. 23, . . | | 7.00 A.M. |
| Nov. 23, . . | .25 [2] | 1.00 P.M. to 10.00 P.M. |
| Nov. 24, . . | 3.44 | 2.10 A.M. to |
| Nov. 26, . . | | 10.15 A.M. |
| Nov. 29, . . | .27 | 5.20 A.M. to 10.00 A.M. |
| Total, . | 4.89 | |
| Dec. 7, . . | .57 | 4.30 P.M. to |
| Dec. 8, . . | | 1.45 A.M. |
| Dec. 13, . . | 1.55 [2] | 8.15 A.M. to |
| Dec. 14, . . | | 6.00 A.M. |
| Dec. 25, . . | 2.27 [1] | 6.00 P.M. to |
| Dec. 26, . . | | 9.00 P.M. |
| Total, . | 4.39 | |

Total for the year 47.62 inches.

[1] Snow.

[2] Rain and snow.

### TABLE NO. 5. — *Rainfall in Inches on the Wachusett Watershed,*[1] *1897 to 1909.*

| YEAR. | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. | Totals. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1897, . . . . . | 3.46 | 2.86 | 4.01 | 2.32 | 5.06 | 5.11 | 8.65 | 3.47 | 1.93 | 0.94 | 7.62 | 6.41 | 51.84 |
| 1898, . . . . . | 6.65 | 3.30 | 2.27 | 4.43 | 3.38 | 3.11 | 3.01 | 10.61 | 3.15 | 7.21 | 6.81 | 3.99 | 57.92 |
| 1899, . . . . . | 2.93 | 5.12 | 6.75 | 1.94 | 1.33 | 5.51 | 3.82 | 3.20 | 4.11 | 2.72 | 1.94 | 2.03 | 41.40 |
| 1900, . . . . . | 4.56 | 8.69 | 6.19 | 2.76 | 4.34 | 3.59 | 3.20 | 3.18 | 3.46 | 2.90 | 6.44 | 3.15 | 52.46 |
| 1901, . . . . . | 1.75 | 1.13 | 5.82 | 9.64 | 7.02 | 1.51 | 5.66 | 4.58 | 3.10 | 3.70 | 2.43 | 9.36 | 55.70 |
| 1902, . . . . . | 2.72 | 4.91 | 5.27 | 4.36 | 2.24 | 2.51 | 3.87 | 3.95 | 4.26 | 6.36 | 0.93 | 7.20 | 48.58 |
| 1903, . . . . . | 2.85 | 4.42 | 6.58 | 3.10 | 1.24 | 10.37 | 3.43 | 3.88 | 2.93 | 4.43 | 2.36 | 3.99 | 49.58 |
| 1904, . . . . . | 4.02 | 2.66 | 3.40 | 7.45 | 2.99 | 3.44 | 3.84 | 3.68 | 5.30 | 1.78 | 1.62 | 2.88 | 43.06 |
| 1905, . . . . . | 6.10 | 1.72 | 3.95 | 2.60 | 0.83 | 4.88 | 5.39 | 3.09 | 6.90 | 1.81 | 2.52 | 3.79 | 43.58 |
| 1906, . . . . . | 2.59 | 2.74 | 5.17 | 3.12 | 6.58 | 5.95 | 5.52 | 4.34 | 2.61 | 3.95 | 2.25 | 4.26 | 49.08 |
| 1907, . . . . . | 2.84 | 2.32 | 1.82 | 2.65 | 2.96 | 3.54 | 3.03 | 1.26 | 9.50 | 5.68 | 5.74 | 4.40 | 45.74 |
| 1908, . . . . . | 3.40 | 4.82 | 2.77 | 2.62 | 5.34 | 1.29 | 3.85 | 6.49 | 1.04 | 2.13 | 1.05 | 3.03 | 37.83 |
| 1909, . . . . . | 3.52 | 6.10 | 4.38 | 5.71 | 2.65 | 3.03 | 4.25 | 3.59 | 3.90 | 1.70 | 1.68 | 3.99 | 44.50 |
| Total, . . . . | 47.39 | 50.79 | 58.38 | 52.70 | 45.96 | 53.84 | 57.52 | 55.32 | 52.19 | 45.31 | 43.39 | 58.48 | 621.27 |
| Average (13 years), | 3.65 | 3.91 | 4.49 | 4.05 | 3.54 | 4.14 | 4.42 | 4.25 | 4.01 | 3.49 | 3.34 | 4.50 | 47.79 |

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[1] Means of observations at four places, as follows: January, 1897, to December, 1900, Princeton, Jefferson, Sterling and South Clinton; January, 1901, to December, 1909, Princeton, Jefferson, Sterling and Boylston.

## TABLE No. 6. — *Rainfall in Inches on the Sudbury Watershed,*[1] *1875 to 1909.*

| YEAR. | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. | Totals. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1875, . . . . . | 2.42 | 3.15 | 3.74 | 3.23 | 3.56 | 6.24 | 3.57 | 5.53 | 3.43 | 4.85 | 4.83 | 0.94 | 45.49 |
| 1876, . . . . . | 1.83 | 4.21 | 7.43 | 4,20 | 2.76 | 2.04 | 9.13 | 1.72 | 4.62 | 2.24 | 5.76 | 3.62 | 49.56 |
| 1877, . . . . . | 3.22 | 0.74 | 8.36 | 3.43 | 3.70 | 2.43 | 2.95 | 3.68 | 0.32 | 8.52 | 5.80 | 0.87 | 44.02 |
| 1878, . . . . . | 5.63 | 5.97 | 4.69 | 5.79 | 0.96 | 3.88 | 2.97 | 6.94 | 1.20 | 6.42 | 7.02 | 6.37 | 57.93 |
| 1879, . . . . . | 2.48 | 3.56 | 5.14 | 4.72 | 1.58 | 3.79 | 3.93 | 6.51 | 1.88 | 0.81 | 2.68 | 4.34 | 41.42 |
| 1880, . . . . . | 3.57 | 3.98 | 3.31 | 3.11 | 1.84 | 2.14 | 6.27 | 4.01 | 1.60 | 3.74 | 1.78 | 2.83 | 38.18 |
| 1881, . . . . . | 5.56 | 4.65 | 5.73 | 2.00 | 3.51 | 5.39 | 2.35 | 1.36 | 2.62 | 2.95 | 4.09 | 3.96 | 44.17 |
| 1882, . . . . . | 5.95 | 4.55 | 2.65 | 1.82 | 5.07 | 1.66 | 1.77 | 1.67 | 8.74 | 2.07 | 1.15 | 2.30 | 39.40 |
| 1883, . . . . . | 2.81 | 3.87 | 1.78 | 1.84 | 4.19 | 2.40 | 2.68 | 0.73 | 1.52 | 5.60 | 1.81 | 3.55 | 32.78 |
| 1884, . . . . . | 5.09 | 6.54 | 4.72 | 4.41 | 3.47 | 3.44 | 3.67 | 4.65 | 0.85 | 2.48 | 2.65 | 5.17 | 47.14 |
| 1885, . . . . . | 4.71 | 3.87 | 1.07 | 3.60 | 3.48 | 2.87 | 1.43 | 7.18 | 1.43 | 5.09 | 6.09 | 2.72 | 43.54 |
| 1886, . . . . . | 6.36 | 6.28 | 3.61 | 2.22 | 3.00 | 1.47 | 3.27 | 4.10 | 2.90 | 3.24 | 4.64 | 4.97 | 46.06 |
| 1887, . . . . . | 5.20 | 4.78 | 4.90 | 4.27 | 1.16 | 2.65 | 3.76 | 5.28 | 1.32 | 2.83 | 2.67 | 3.88 | 42.70 |
| 1888, . . . . . | 4.15 | 3.68 | 6.02 | 2.48 | 4.82 | 2.54 | 1.41 | 6.22 | 8.59 | 4.99 | 7.22 | 5.40 | 57.47 |
| 1889, . . . . . | 5.37 | 1.65 | 2.37 | 3.41 | 2.95 | 2.80 | 8.94 | 4.18 | 4.60 | 4.25 | 6.29 | 3.14 | 49.95 |
| 1890, . . . . . | 2.53 | 3.51 | 7.73 | 2.64 | 5.21 | 2.08 | 2.46 | 3.87 | 6.00 | 10.51 | 1.20 | 5.31 | 53.00 |
| 1891, . . . . . | 7.02 | 5.23 | 6.48 | 3.91 | 2.01 | 3.77 | 3.39 | 4.73 | 2.38 | 3.83 | 3.09 | 3.68 | 49.52 |
| 1892, . . . . . | 5.85 | 3.14 | 4.06 | 0.83 | 5.58 | 2.76 | 4.23 | 4.44 | 2.84 | 1.17 | 5.80 | 1.13 | 41.83 |
| 1893, . . . . . | 2.92 | 8.20 | 3.67 | 3.60 | 6.61 | 2.38 | 2.57 | 5.41 | 1.74 | 4.07 | 2.20 | 4.86 | 48.23 |
| 1894, . . . . . | 4.09 | 3.91 | 1.43 | 3.42 | 4.24 | 1.15 | 3.26 | 2.08 | 2.63 | 5.34 | 3.43 | 4.81 | 39.74 |
| 1895, . . . . . | 4.06 | 1.39 | 2.98 | 5.25 | 2.02 | 2.77 | 5.04 | 4.15 | 2.30 | 10.68 | 6.63 | 3.35 | 50.62 |
| 1896, . . . . . | 2.39 | 7.18 | 5.24 | 1.57 | 2.57 | 3.22 | 2.51 | 2.40 | 7.72 | 3.76 | 3.02 | 2.12 | 43.70 |
| 1897, . . . . . | 4.00 | 2.91 | 3.66 | 2.82 | 4.37 | 4.46 | 5.44 | 3.51 | 2.94 | 0.47 | 6.40 | 5.21 | 46.19 |
| 1898, . . . . . | 6.83 | 4.49 | 2.40 | 4.66 | 3.22 | 2.48 | 4.09 | 8.17 | 2.62 | 6.71 | 6.98 | 3.28 | 55.88 |
| 1899, . . . . . | 4.18 | 4.91 | 7.01 | 1.90 | 1.45 | 2.51 | 3.22 | 1.43 | 3.95 | 2.69 | 2.18 | 1.78 | 37.21 |
| 1900, . . . . . | 4.96 | 9.14 | 6.35 | 2.58 | 4.32 | 2.99 | 2.42 | 2.26 | 3.36 | 3.83 | 5.70 | 2.74 | 50.65 |
| 1901, . . . . . | 1.82 | 1.52 | 6.57 | 8.60 | 7.23 | 1.38 | 5.71 | 4.57 | 3.30 | 2.82 | 2.90 | 9.69 | 56.11 |
| 1902, . . . . . | 2.52 | 6.18 | 5.34 | 4.13 | 1.86 | 2.89 | 2.94 | 3.40 | 4.54 | 4.44 | 1.45 | 6.38 | 46.07 |
| 1903, . . . . . | 3.80 | 3.95 | 6.63 | 2.99 | 0.93 | 9.25 | 2.77 | 3.67 | 1.75 | 4.72 | 1.56 | 3.14 | 45.16 |
| 1904, . . . . . | 4.87 | 3.00 | 2.72 | 8.87 | 2.65 | 2.80 | 1.96 | 3.86 | 5.80 | 1.64 | 1.73 | 2.92 | 42.82 |
| 1905, . . . . . | 5.26 | 2.20 | 3.15 | 2.72 | 1.31 | 5.00 | 5.47 | 2.70 | 6.88 | 1.54 | 2.07 | 4.01 | 42.31 |
| 1906, . . . . . | 2.47 | 2.92 | 6.32 | 2.88 | 5.66 | 3.91 | 3.42 | 3.02 | 3.30 | 3.40 | 2.69 | 4.49 | 44.48 |
| 1907, . . . . . | 3.28 | 2.17 | 1.91 | 3.41 | 3.63 | 3.53 | 1.86 | 1.07 | 8.76 | 4.17 | 6.12 | 4.47 | 44.38 |
| 1908, . . . . . | 3.60 | 4.56 | 3.82 | 1.88 | 5.51 | 0.86 | 3.71 | 4.57 | 0.97 | 2.55 | 0.98 | 3.14 | 36.15 |
| 1909, . . . . . | 3.98 | 5.79 | 4.26 | 4.67 | 2.43 | 2.81 | 1.59 | 2.93 | 4.74 | 1.12 | 3.38 | 4.05 | 41.75 |
| Total, . . . | 144.78 | 147.78 | 157.25 | 123.81 | 118.86 | 108.69 | 126.16 | 135.95 | 124.23 | 139.54 | 133.94 | 134.62 | 1,595.61 |
| Average (35 years), | 4.14 | 4.22 | 4.49 | 3.54 | 3.40 | 3.10 | 3.60 | 3.88 | 3.55 | 3.99 | 3.83 | 3.85 | 45.59 |

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[1] Means of observations at several places, as follows: January, 1875, to April, 1876, Lake Cochituate; April to June, 1876, Lake Cochitnate, Westborough and Hopkinton; June to December, 1876, Lake Cochituate, Southborough, Marlborough, Westborough and Hopkinton; December, 1876, to January, 1883, Framingham, Southborough, Marlborough, Westborough and Hopkinton; January, 1883, to January, 1884, Framingham and Southborough; January, 1884, to January, 1890, Framingham and Westborough; January, 1890, to May, 1898, Framingham and Ashland Dam; June, 1898, to December, 1909, Framingham, Ashland Dam, Cordaville and Sudbury Dam.

TABLE No. 7. — *Yield of the Wachusett Watershed in Gallons per Day per Square Mile* [1] *from 1897 to 1909.*

| MONTH. | 1897. | 1898. | 1899. | 1900. | 1901. | 1902. | 1903. | 1904. | 1905. | 1906. | 1907. | 1908. | 1909. | Mean for 13 Years. 1897-1909. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January, | 796,000 | 1,563,000 | 2,092,000 | 796,000 | 519,000 | 1,676,000 | 1,265,000 | 659,000 | 1,266,000 | 1,132,000 | 1,458,000 | 1,738,000 | 592,000 | 1,196,000 |
| February, | 931,000 | 1,635,000 | 1,090,000 | 4,054,000 | 856,000 | 1,401,000 | 2,188,000 | 927,000 | 452,000 | 1,027,000 | 692,000 | 1,786,000 | 2,556,000 | 1,460,000 |
| March, | 2,760,000 | 3,088,000 | 2,776,000 | 3,722,000 | 2,718,000 | 3,902,000 | 3,423,000 | 3,008,000 | 3,004,000 | 1,860,000 | 1,697,000 | 2,192,000 | 2,129,000 | 2,798,000 |
| April, | 1,632,000 | 2,027,000 | 3,376,000 | 1,580,000 | 4,986,000 | 2,159,000 | 2,238,000 | 2,984,000 | 1,617,000 | 2,109,000 | 1,436,000 | 1,269,000 | 2,422,000 | 2,295,000 |
| May, | 1,163,000 | 1,390,000 | 862,000 | 1,382,000 | 2,729,000 | 1,031,000 | 569,000 | 1,498,000 | 445,000 | 1,533,000 | 965,000 | 1,415,000 | 1,212,000 | 1,246,000 |
| June, | 1,181,000 | 828,000 | 561,000 | 578,000 | 985,000 | 410,000 | 2,131,000 | 762,000 | 542,000 | 1,184,000 | 773,000 | 403,000 | 632,000 | 844,000 |
| July, | 1,442,000 | 333,000 | 354,000 | 217,000 | 477,000 | 292,000 | 624,000 | 497,000 | 365,000 | 728,000 | 335,000 | 220,000 | 233,000 | 471,000 |
| August, | 896,000 | 1,325,000 | 236,000 | 197,000 | 512,000 | 297,000 | 474,000 | 355,000 | 321,000 | 591,000 | 87,000 | 443,000 | 198,000 | 456,000 |
| September, | 380,000 | 676,000 | 250,000 | 127,000 | 320,000 | 241,000 | 375,000 | 494,000 | 1,228,000 | 277,000 | 810,000 | 88,000 | 208,000 | 421,000 |
| October, | 243,000 | 1,509,000 | 245,000 | 282,000 | 647,000 | 950,000 | 689,000 | 847,000 | 867,000 | 530,000 | 1,382,000 | 158,000 | 90,000 | 572,000 |
| November, | 1,283,000 | 2,170,000 | 430,000 | 875,000 | 517,000 | 685,000 | 634,000 | 843,000 | 442,000 | 749,000 | 2,540,000 | 125,000 | 363,000 | 854,000 |
| December, | 2,275,000 | 2,061,000 | 359,000 | 1,570,000 | 3,234,000 | 1,848,000 | 954,000 | 440,000 | 1,018,000 | 794,000 | 1,961,000 | 887,000 | 537,000 | 1,341,000 |
| Average for year, | 1,253,000 | 1,551,000 | 1,051,000 | 1,264,000 | 1,507,000 | 1,248,000 | 1,285,000 | 1,025,000 | 926,000 | 1,043,000 | 1,180,000 | 847,000 | 918,000 | 1,161,000 |
| Average for driest six months, | 886,000 | 1,013,000 | 312,000 | 377,000 | 576,000 | 471,000 | 626,000 | 413,000 | 541,000 | 613,000 | 725,000 | 288,000 | 270,000 | 601,000 |

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[1] The area of the watershed used in making up these records included water surfaces amounting to 2.2 per cent. of the whole area from 1897 to 1902, inclusive, to 2.4 per cent. in 1903, to 3.6 per cent. in 1904, to 4.1 per cent. in 1905, to 5.1 per cent. in 1906, to 6.0 per cent. in 1907, to 7.0 per cent. in 1908 and 1909.

TABLE No. 8. — *Yield of the Sudbury Watershed in Gallons per Day per Square Mile* [1] *from 1875 to 1909.*

| MONTH. | 1875. | 1876. | 1877. | 1878. | 1879. | 1880. | 1881. | 1882. | 1883. | 1884. | 1885. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| January, | 103,000 | 643,000 | 658,000 | 1,810,000 | 700,000 | 1,120,000 | 415,000 | 1,241,000 | 335,000 | 995,000 | 1,235,000 |
| February, | 1,496,000 | 1,368,000 | 949,000 | 2,465,000 | 1,711,000 | 1,787,000 | 1,546,000 | 2,403,000 | 1,033,000 | 2,842,000 | 1,354,000 |
| March, | 1,604,060 | 4,435,000 | 4,814,000 | 3,507,000 | 2,330,000 | 1,374,000 | 4,004,000 | 2,839,000 | 1,611,000 | 3,785,000 | 1,572,000 |
| April, | 3,049,000 | 3,292,000 | 2,394,000 | 1,626,000 | 3,116,000 | 1,169,000 | 1,546,000 | 867,000 | 1,350,000 | 2,853,000 | 1,815,000 |
| May, | 1,188,000 | 1,138,000 | 1,391,000 | 1,394,000 | 1,114,000 | 514,000 | 965,000 | 1,292,000 | 937,000 | 1,030,000 | 1,336,000 |
| June, | 870,000 | 222,000 | 597,000 | 506,000 | 413,000 | 175,000 | 1,338,000 | 529,000 | 300,000 | 416,000 | 426,000 |
| July, | 321,000 | 183,000 | 202,000 | 128,000 | 157,000 | 176,000 | 276,000 | 86,000 | 115,000 | 224,000 | 62,000 |
| August, | 396,000 | 405,000 | 121,000 | 476,000 | 395,000 | 119,000 | 148,000 | 55,000 | 79,000 | 257,000 | 240,000 |
| September, | 207,000 | 184,000 | 60,000 | 161,000 | 141,000 | 80,000 | 197,000 | 307,000 | 91,000 | 44,000 | 121,000 |
| October, | 646,000 | 234,000 | 631,000 | 516,000 | 71,000 | 102,000 | 186,000 | 299,000 | 186,000 | 83,000 | 336,000 |
| November, | 1,302,000 | 1,088,000 | 1,418,000 | 1,693,000 | 206,000 | 205,000 | 395,000 | 209,000 | 205,000 | 175,000 | 1,177,000 |
| December, | 584,000 | 453,000 | 1,290,000 | 3,177,000 | 463,000 | 175,000 | 775,000 | 315,000 | 194,000 | 925,000 | 1,174,000 |
| Average for year, | 972,000 | 1,135,000 | 1,214,000 | 1,452,000 | 894,000 | 578,000 | 979,000 | 862,000 | 533,000 | 1,129,000 | 901,000 |
| Average for driest six months, | 574,000 | 384,000 | 502,000 | 532,000 | 230,000 | 143,000 | 330,000 | 211,000 | 145,000 | 200,000 | 391,000 |

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[1] The area of the Sudbury watershed used in making up these records included water surfaces amounting to 1.9 per cent. of the whole area from 1875 to 1878, inclusive, and was subsequently increased by the construction of storage reservoirs to 3.0 per cent. in 1879, 8.4 per cent. in 1885, 3.9 per cent. in 1894 and 6.5 per cent. in 1898. The watershed also contains extensive areas of swampy land, which, though covered with water at times, are not included in the above percentages of water surfaces.

TABLE No. 8. — *Yield of the Sudbury Watershed in Gallons per Day per Square Mile*[1] *from 1875 to 1909* — Continued.

| MONTH. | 1886. | 1887. | 1888. | 1889. | 1890. | 1891. | 1892. | 1893. | 1894. | 1895. | 1896. | 1897. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January, | 1,461,000 | 2,589,000 | 1,053,000 | 2,782,000 | 1,254,000 | 3,018,000 | 1,870,000 | 434,000 | 693,000 | 1,034,000 | 1,084,000 | 845,000 |
| February, | 4,801,000 | 2,829,000 | 1,950,000 | 1,196,000 | 1,529,000 | 3,486,000 | 943,000 | 1,542,000 | 991,000 | 541,000 | 2,676,000 | 1,067,000 |
| March, | 2,059,000 | 2,868,000 | 3,238,000 | 1,338,000 | 3,643,000 | 4,453,000 | 1,955,000 | 3,245,000 | 2,238,000 | 2,410,000 | 3,835,000 | 2,565,000 |
| April, | 1,947,000 | 2,620,000 | 2,645,000 | 1,410,000 | 1,875,000 | 2,397,000 | 871,000 | 2,125,000 | 1,640,000 | 2,515,000 | 1,494,000 | 1,515,000 |
| May, | 720,000 | 1,009,000 | 1,632,000 | 880,000 | 1,366,000 | 583,000 | 1,259,000 | 2,883,000 | 840,000 | 636,000 | 360,000 | 915,000 |
| June, | 203,000 | 413,000 | 421,000 | 653,000 | 568,000 | 413,000 | 428,000 | 440,000 | 419,000 | 174,000 | 399,000 | 962,000 |
| July, | 116,000 | 115,000 | 117,000 | 634,000 | 107,000 | 149,000 | 214,000 | 158,000 | 161,000 | 231,000 | 95,000 | 658,000 |
| August, | 94,000 | 214,000 | 379,000 | 1,432,000 | 132,000 | 163,000 | 280,000 | 181,000 | 209,000 | 229,000 | 57,000 | 591,000 |
| September, | 117,000 | 111,000 | 1,155,000 | 823,000 | 457,000 | 203,000 | 229,000 | 108,000 | 150,000 | 89,000 | 388,000 | 182,000 |
| October, | 146,000 | 190,000 | 1,999,000 | 1,230,000 | 2,272,000 | 210,000 | 126,000 | 222,000 | 374,000 | 1,379,000 | 592,000 | 94,000 |
| November, | 673,000 | 369,000 | 2,758,000 | 1,941,000 | 1,215,000 | 305,000 | 697,000 | 319,000 | 836,000 | 2,777,000 | 659,000 | 909,000 |
| December, | 1,020,000 | 643,000 | 3,043,000 | 2,241,000 | 996,000 | 544,000 | 485,000 | 796,000 | 716,000 | 1,782,000 | 657,000 | 1,584,000 |
| Average for year, | 1,087,000 | 1,154,000 | 1,697,000 | 1,383,000 | 1,285,000 | 1,315,000 | 781,000 | 1,037,000 | 770,000 | 1,152,000 | 1,019,000 | 991,000 |
| Average for driest six months, | 223,000 | 234,000 | 953,000 | 944,000 | 747,000 | 239,000 | 327,000 | 237,000 | 356,000 | 460,000 | 314,000 | 564,000 |

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[1] The area of the Sudbury watershed used in making up these records included water surfaces amounting to 1.9 per cent. of the whole area from 1875 to 1878, inclusive, and was subsequently increased by the construction of storage reservoirs to 3.0 per cent. in 1879, 3.4 per cent. in 1885, 3.9 per cent. in 1894, and 6.5 per cent. in 1898. The watershed also contains extensive areas of swampy land, which, though covered with water at times, are not included in the above percentages of water surfaces.

TABLE NO. 8. — *Yield of the Sudbury Watershed in Gallons per Day per Square Mile*[1] *from 1875 to 1909* — Concluded.

| MONTH. | 1898. | 1899. | 1900. | 1901. | 1902. | 1903. | 1904. | 1905. | 1906. | 1907. | 1908. | 1909. | Mean for 35 Years, 1875-1909. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January, . . . . | 1,638,000 | 2,288,000 | 794,000 | 437,000 | 1,763,000 | 1,736,000 | 477,000 | 1,410,000 | 1,128,000 | 1,851,000 | 1,925,000 | 392,000 | 1,220,000 |
| February, . . . . | 3,022,000 | 1,381,000 | 3,800,000 | 300,000 | 1,674,000 | 2,279,000 | 882,000 | 330,000 | 1,041,000 | 624,000 | 1,536,000 | 2,286,000 | 1,762,000 |
| March, . . . . . | 2,604,000 | 4,205,000 | 3,654,000 | 2,755,000 | 4,199,000 | 3,454,000 | 2,999,000 | 2,497,000 | 2,409,000 | 1,658,000 | 2,257,000 | 1,734,000 | 2,861,000 |
| April, . . . . . | 1,829,000 | 2,521,000 | 1,350,000 | 4,204,000 | 1,885,000 | 2,261,000 | 3,294,000 | 1,643,000 | 1,949,000 | 1,607,000 | 1,117,000 | 1,721,000 | 2,043,000 |
| May, . . . . . | 1,246,000 | 511,000 | 1,312,000 | 2,954,000 | 743,000 | 351,000 | 1,745,000 | 297,000 | 1,059,000 | 888,000 | 1,046,000 | 1,004,000 | 1,101,000 |
| June, . . . . . | 530,000 | 66,000 | 316,000 | 753,000 | 303,000 | 1,987,000 | 419,000 | 467,000 | 707,000 | 761,000 | 194,000 | 289,000 | 515,000 |
| July, . . . . . | 231,000 | 19,000 | –18,000 | 306,000 | 66,000 | 445,000 | 62,000 | 177,000 | 398,000 | 9,000 | —14,000 | —121,000 | 178,000 |
| August, . . . . | 1,107,000 | —35,000 | —34,000 | 424,000 | 135,000 | 307,000 | 170,000 | 114,000 | 180,000 | —104,000 | 102,000 | —45,000 | 256,000 |
| September, . . . . | 369,000 | 94,000 | 65,000 | 305,000 | 178,000 | 130,000 | 397,000 | 1,246,000 | 19,000 | 541,000 | —82,000 | 149,000 | 258,000 |
| October, . . . . | 1,160,000 | 115,000 | 186,000 | 412,000 | 506,000 | 492,000 | 191,000 | 158,000 | 301,000 | 741,000 | 47,000 | —51,000 | 468,000 |
| November, . . . . | 1,986,000 | 304,000 | 663,000 | 474,000 | 444,000 | 363,000 | 289,000 | 279,000 | 483,000 | 1,998,000 | 71,000 | 82,000 | 828,000 |
| December, . . . . | 1,799,000 | 220,000 | 1,096,000 | 2,695,000 | 1,779,000 | 582,000 | 269,000 | 887,000 | 659,000 | 2,082,000 | 186,000 | 263,000 | 1,041,000 |
| Average for year, . | 1,450,000 | 973,000 | 1,082,000 | 1,342,000 | 1,140,000 | 1,190,000 | 931,000 | 795,000 | 860,000 | 1,010,000 | 694,000 | 625,000 | 1,040,000 |
| Average for driest six months, . . . | 777,000 | 93,000 | 194,000 | 445,000 | 271,000 | 388,000 | 228,000 | 403,000 | 341,000 | 471,000 | 44,000 | 40,000 | 415,000 |

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[1] The area of the Sudbury watershed used in making up these records included water surfaces amounting to 1.9 per cent. of the whole area from 1875 to 1878, inclusive, and was subsequently increased by the construction of storage reservoirs to 3.0 per cent. in 1879, 3.4 per cent. in 1885, 3.9 per cent. in 1894 and 6.5 per cent. in 1898. The watershed also contains extensive areas of swampy land, which, though covered with water at times, are not included in the above percentages of water surfaces.

NOTE. — The recorded yields, subsequent to the year 1897, are less accurate than those for previous years, due to unavoidable inaccuracies in the measurement of the quantity of water received from the Wachusett Reservoir.

TABLE No. 9. — *Wachusett System. — Statistics of Flow of Water, Storage and Rainfall in 1909.*

[Watershed above dam = 118.19 square miles.]

| MONTH. | Quantity of Water discharged through Wachusett Aqueduct (Gallons per Day).[1] | Quantity of Water wasted into River below Dam (Gallons per Day). | STORAGE.[2] |  | Total Yield of Watershed (Gallons per Day). | Rainfall (Inches). | Rainfall collected (Inches). | Percentage of Rainfall collected. |
|---|---|---|---|---|---|---|---|---|
|  |  |  | Gain (Gallons per Day). | Loss (Gallons per Day). |  |  |  |  |
| January, | 119,010,000 | 2,987,000 | - | 52,042,000 | 69,955,000 | 3.52 | 1.056 | 30.0 |
| February, | 39,175,000 | 2,579,000 | 260,371,000 | - | 302,125,000 | 6.10 | 4.118 | 67.5 |
| March, | 94,485,000 | 2,858,000 | 154,361,000 | - | 251,655,000 | 4.38 | 3.798 | 86.8 |
| April, | 84,677,000 | 2,690,000 | 198,900,000 | - | 286,267,000 | 5.71 | 4.181 | 73.3 |
| May, | 98,461,000 | 2,661,000 | 42,142,000 | - | 143,265,000 | 2.65 | 2.162 | 81.7 |
| June, | 102,233,000 | 3,157,000 | - | 30,747,000 | 74,660,000 | 3.03 | 1.091 | 36.0 |
| July, | 111,742,000 | 3,213,000 | - | 87,406,000 | 27,548,000 | 4.25 | 0.416 | 9.8 |
| August, | 104,423,000 | 3,400,000 | - | 84,961,000 | 22,861,000 | 3.59 | 0.345 | 9.6 |
| September, | 51,133,000 | 2,543,000 | - | 29,147,000 | 24,530,000 | 3.90 | 0.358 | 9.2 |
| October, | 93,561,000 | 1,532,000 | - | 84,481,000 | 10,613,000 | 1.70 | 0.160 | 9.4 |
| November, | 182,893,000 | 1,657,000 | - | 141,660,000 | 42,890,000 | 1.68 | 0.627 | 37.2 |
| December, | 105,171,000 | 1,158,000 | - | 42,848,000 | 63,481,000 | 3.99 | 0.958 | 24.0 |
| Total, | - | - | - | - | - | 44.50 | 19.270 | - |
| Average for year, | 99,331,000 | 2,536,000 | 6,571,000 | - | 108,440,000 | - | - | 43.3 |

[1] Including 7.1 million gallons, drawn from aqueduct for the supply of the Westborough Insane Hospital, between November 7 and January 1, 1910.

[2] Aggregate storage in Wachusett Reservoir and in ponds and mill reservoirs.

### TABLE No. 10. — *Sudbury System. — Statistics of Flow of Water, Storage and Rainfall in 1909.*

[Watershed from 1875 to 1878 inclusive = 77.764 square miles; in 1879 and 1880 = 78.238 square miles; and from 1881 to 1909 inclusive = 75.2 square miles.]

| MONTH. | Quantity of Water received through Wachusett Aqueduct (Gallons per Day).[1] | Quantity of Water discharged through Sudbury Aqueduct (Gallons per Day). | Quantity of Water discharged through Weston Aqueduct (Gallons per Day).[2] | Quantity of Water used by Framingham Water Works (Gallons per Day). | Quantity of Water diverted from Watershed by Sewers, etc. (Gallons per Day). | Quantity of Water wasted into River below Lowest Dam (Gallons per Day). | STORAGE. | | Total Yield of Watershed (Gallons per Day). | Rainfall (Inches). | Rainfall collected (Inches). | Percentage of Rainfall collected. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Gain (Gallons per Day). | Loss (Gallons per Day). | | | | |
| January, . . | 119,010,000 | 94,397,000 | 31,042,000 | 610,000 | 539,000 | 3,965,000 | 17,965,000 | - | 29,506,000 | 3.98 | 0.700 | 17.6 |
| February, . . | 39,175,000 | 94,025,000 | 29,557,000 | 593,000 | 1,154,000 | 79,939,000 | 5,836,000 | - | 171,929,000 | 5.79 | 3.684 | 63.6 |
| March, . . . | 94,435,000 | 90,174,000 | 29,971,000 | 555,000 | 1,261,000 | 86,006,000 | 16,861,000 | - | 130,394,000 | 4.26 | 3.093 | 72.7 |
| April, . . . | 84,677,000 | 88,687,000 | 29,690,000 | 603,000 | 1,467,000 | 77,353,000 | 16,273,000 | - | 129,397,000 | 4.67 | 2.970 | 63.6 |
| May, . . . | 98,461,000 | 91,419,000 | 29,326,000 | 552,000 | 1,284,000 | 50,097,000 | 1,265,000 | - | 75,461,000 | 2.43 | 1.791 | 73.8 |
| June, . . . | 102,233,000 | 75,370,000 | 28,747,000 | 670,000 | 783,000 | 13,057,000 | 1,613,000 | - | 18,007,000 | 2.81 | 0.413 | 14.7 |
| July, . . . | 111,742,000 | 76,197,000 | 28,977,000 | 677,000 | 445,000 | 1,655,000 | - | 5,313,000 | —9,103,000 | 1.59 | —0.216 | —13.5 |
| August, . . | 104,423,000 | 73,335,000 | 27,687,000 | 616,000 | 365,000 | 1,632,000 | - | 2,574,000 | —3,361,000 | 2.93 | —0.080 | —2.7 |
| September, . . | 51,133,000 | 71,820,000 | 29,757,000 | 580,000 | 403,000 | 2,140,000 | - | 42,360,000 | 11,207,000 | 4.74 | 0.257 | 5.4 |
| October, . . | 93,561,000 | 86,626,000 | 29,790,000 | 584,000 | 461,000 | 3,826,000 | - | 31,587,000 | —3,861,000 | 1.12 | —0.092 | —8.2 |
| November, . . | 182,790,000 | 78,673,000 | 29,487,000 | 547,000 | 537,000 | 10,540,000 | 69,193,000 | - | 6,187,000 | 3.38 | 0.142 | 4.2 |
| December, . . | 105,042,000 | 81,826,000 | 29,761,000 | 539,000 | 594,000 | 13,652,000 | - | 1,568,000 | 19,761,000 | 4.05 | 0.469 | 11.6 |
| Total, . . | - | - | - | - | - | - | - | - | - | 41.75 | 13.131 | - |
| Av. for year, . | 99,312,000 | 83,513,000 | 29,463,000 | 594,000 | 771,000 | 28,265,000 | 3,703,000 | - | 47,017,000 | - | - | 31.5 |

[1] Not including 7.1 million gallons drawn through Wachusett Aqueduct for the supply of the Westborough Insane Hospital, between November 7 and January 1, 1910, which were not discharged into Sudbury Reservoir.

[2] Including quantities of water wasted from aqueduct.

### TABLE NO. 11. — *Cochituate System. — Statistics of Flow of Water, Storage and Rainfall in 1909.*

[Watershed of lake = 18.87 square miles.[1]]

| MONTH. | Quantity of Water discharged through Cochituate Aqueduct (Gallons per Day). | Quantity of Water diverted from Watershed by Sewers, etc. (Gallons per Day.) | Quantity of Water wasted at Outlet of Lake (Gallons per Day). | STORAGE. | | Total Yield of Watershed (Gallons per Day.) | Rainfall (Inches). | Rainfall collected (Inches). | Percentage of Rainfall collected. |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Gain (Gallons per Day). | Loss (Gallons per Day). | | | | |
| January, | 3,581,000 | 210,000 | - | 3,935,000 | - | 7,726,000 | 4.34 | 0.73 | 16.8 |
| February, | 1,096,000 | 621,000 | 21,621,000 | 15,582,000 | - | 38,921,000 | 5.66 | 3.32 | 58.7 |
| March, | - | 919,000 | 23,074,000 | 1,923,000 | - | 25,916,000 | 3.98 | 2.45 | 61.5 |
| April, | 2,123,000 | 1,123,000 | 22,743,000 | 173,000 | - | 26,163,000 | 4.50 | 2.39 | 53.2 |
| May, | - | 877,000 | 14,313,000 | - | 335,000 | 14,855,000 | 2.05 | 1.40 | 68.5 |
| June, | 17,200,000 | 417,000 | 527,000 | - | 10,853,000 | 7,290,000 | 3.09 | 0.67 | 21.6 |
| July, | 21,119,000 | 174,000 | - | - | 19,090,000 | 2,203,000 | 1.73 | 0.21 | 12.0 |
| August, | 20,487,000 | 142,000 | - | - | 15,358,000 | 5,271,000 | 2.84 | 0.50 | 17.5 |
| September, | 15,380,000 | 167,000 | - | - | 7,520,000 | 8,027,000 | 4.33 | 0.74 | 17.0 |
| October, | - | 200,000 | - | 1,535,000 | - | 1,735,000 | 1.06 | 0.16 | 15.5 |
| November, | - | 230,000 | - | 4,313,000 | - | 4,543,000 | 3.76 | 0.42 | 11.1 |
| December, | - | 410,000 | - | 6,390,000 | - | 6,800,000 | 4.10 | 0.64 | 15.7 |
| Total, | - | - | - | - | - | - | 41.44 | 13.63 | - |
| Average for year, | 6,774,000 | 456,000 | 6,747,000 | - | 1,729,000 | 12,247,000 | - | - | 32.9 |

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[1] Not including the watershed of Dudley Pond.

TABLE NO. 12. — *Elevations of Water Surfaces of Reservoirs above Boston City Base at the Beginning of Each Month.*

| DATE. | Chestnut Hill Reservoir. Ordinary High Water =134.00. | Lake Cochituate. High Water =144.36. | Farm Pond. High Water =159.25. | Spot Pond. High Water =163.00. | Weston Reservoir. High Water =200.00. | FRAMINGHAM RESERVOIR. No. 1. Flash Boards 169.27. | FRAMINGHAM RESERVOIR. No. 2. Flash Boards 177.12. | FRAMINGHAM RESERVOIR. No. 3. Flash Boards 186.50. | Ashland Reservoir. Flash Boards 225.23. | Sudbury Reservoir. Flash Boards 259.97. | Hopkinton Reservoir. Flash Boards 305.00. | Whitehall Reservoir. Ordinary High Water =337.91. | Wachusett Reservoir. Ordinary High Water =395.00. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan. 1, 1909, . | 134.07 | 141.78 | 158.04 | 163.27 | 200.00 | 167.69 | 175.98 | 183.97 | 224.36 | 255.77 | 304.11 | 336.90 | 379.87 |
| Feb. 1, 1909, . | 133.36 | 142.33 | 158.23 | 163.24 | 200.01 | 167.57 | 176.00 | 183.88 | 224.38 | 257.56 | 300.27 | 337.96 | 378.92 |
| Mar. 1, 1909, . | 134.14 | 144.15 | 158.86 | 163.25 | 199.98 | 168.01 | 176.30 | 183.78 | 224.21 | 257.08 | 304.33 | 337.60 | 384.42 |
| April 1, 1909, . | 133.94 | 144.38 | 158.92 | 163.20 | 200.15 | 168.04 | 176.33 | 181.23 | 224.67 | 258.87 | 304.42 | 337.82 | 388.29 |
| May 1, 1909, . | 134.04 | 144.40 | 158.92 | 163.07 | 200.07 | 168.04 | 176.34 | 183.80 | 224.68 | 259.25 | 304.42 | 337.98 | 392.94 |
| June 1, 1909, . | 134.01 | 144.36 | 158.67 | 163.09 | 200.05 | 167.81 | 177.34 | 183.61 | 225.10 | 259.26 | 304.82 | 337.89 | 394.05 |
| July 1, 1909, . | 132.76 | 143.05 | 158.26 | 163.05 | 200.01 | 169.29 | 177.15 | 183.94 | 225.31 | 259.28 | 304.95 | 337.66 | 393.54 |
| Aug. 1, 1909, . | 132.69 | 140.37 | 157.74 | 162.90 | 200.06 | 169.21 | 177.11 | 184.04 | 225.07 | 259.23 | 304.52 | 337.96 | 391.61 |
| Sept. 1, 1909, . | 132.30 | 137.98 | 157.45 | 163.10 | 199.76 | 169.14 | 177.11 | 183.50 | 224.93 | 259.28 | 304.39 | 337.14 | 389.64 |
| Oct. 1, 1909, . | 133.10 | 136.28 | 157.48 | 162.95 | 200.11 | 169.39 | 177.19 | 183.82 | 225.14 | 255.95 | 304.45 | 337.31 | 388.98 |
| Nov. 1, 1909, . | 134.11 | 136.96 | 157.25 | 163.08 | 199.99 | 167.87 | 177.16 | 183.92 | 225.05 | 253.75 | 304.36 | 337.18 | 386.98 |
| Dec. 1, 1909, . | 133.77 | 137.72 | 157.37 | 163.10 | 200.04 | 167.69 | 176.00 | 183.32 | 224.85 | 259.18 | 304.16 | 337.87 | 383.29 |
| Jan. 1, 1910, . | 133.42 | 138.76 | 157.58 | 162.86 | 200.00 | 167.65 | 175.99 | 182.41 | 224.35 | 259.28 | 304.12 | 337.24 | 382.09 |

LE No. 13. — *Sources from which and Periods during which Water has been drawn for the Supply of the Metropolitan Water District.*

*From Wachusett Reservoir into Sudbury Reservoir.*

7:00 A.M. Jan. 1 to 3:50 P.M. Feb. 10.
11:10 A.M. Feb. 19 " 12:00 M. Feb. 20.
5:20 P.M. Mar. 8 " 9:50 A.M. Apr. 15.
7:00 P.M. Apr. 18 " 10:50 A.M. Apr. 30.
7:00 P.M. May 3 " 10:00 A.M. Aug. 18.
5:00 P.M. Aug. 19 " 10:00 P.M. Sept. 12.
5:00 P.M. Sept. 18 " 9:00 P.M. Sept. 18.
7:00 P.M. Oct. 2 " 7:00 A.M. Oct. 3.
5:00 P.M. Oct. 9 " 7:00 A.M. Jan. 1, 1910.
Total quantity, 36,255,900,000 gallons.

*From Sudbury Reservoir through the Weston Aqueduct to the Weston Reservoir.*

7:00 A.M. Jan. 1 to 7:00 A.M. Jan. 11.
4:30 P.M. Jan. 12 " 6:00 A.M. Jan. 14.
5:00 P.M. Jan. 15 " 11:00 P.M. Jan. 17.
5:00 P.M. Jan. 20 " 7:00 A.M. Jan. 1, 1910.
Total quantity, 10,745,600,000 gallons.

*m Framingham Reservoir No. 2 through Sudbury Aqueduct to Chestnut Hill Reservoir.*

7:00 A.M. Jan. 7 to 11:00 A.M. Feb. 12.
Total quantity, 900,600,000 gallons.

*m Framingham Reservoir No. 3 through Sudbury Aqueduct to Chestnut Hill Reservoir.*

7:00 A.M. Jan. 1 to 7:00 A.M. Jan. 1, 1910.
Total quantity, 29,581,800,000 gallons.

*From Lake Cochituate through Cochituate Aqueduct to Chestnut Hill Reservoir.*

1:00 P.M. Jan. 26 to 5:15 P.M. Feb. 2.
7:00 A.M. Apr. 2 " 12:00 M. Apr. 5.
8:00 A.M. June 6 " 8:00 A.M. June 23.
9:30 A.M. June 23 " 9:00 A.M. July 9.
10:00 A.M. July 9 " 1:00 P.M. Sept. 29.
Total quantity, 2,472,600,000 gallons.

TABLE No. 14. — *Average Daily Quantity of Water flowing through Aqueducts in 1909 by Months.*[1]

| MONTH. | Wachusett Aqueduct into Sudbury Reservoir (Gallons). | Weston Aqueduct into Metropolitan District (Gallons). | Sudbury Aqueduct into Chestnut Hill Reservoir (Gallons). | Cochituate Aqueduct into Chestnut Hill Reservoir (Gallons). |
|---|---|---|---|---|
| January, | 119,010,000 | 30,539,000 | 94,397,000 | 3,581,000 |
| February, | 89,175,000 | 29,557,000 | 94,025,000 | 1,096,000 |
| March, | 94,435,000 | 29,971,000 | 90,174,000 | - |
| April, | 84,677,000 | 29,690,000 | 88,687,000 | 2,123,000 |
| May, | 98,461,000 | 29,326,000 | 91,419,000 | - |
| June, | 102,233,000 | 28,747,000 | 75,370,000 | 17,200,000 |
| July, | 111,742,000 | 28,977,000 | 76,197,000 | 21,119,000 |
| August, | 104,423,000 | 27,687,000 | 73,335,000 | 20,487,000 |
| September, | 51,133,000 | 29,757,000 | 71,820,000 | 15,380,000 |
| October, | 93,561,000 | 29,790,000 | 86,626,000 | - |
| November, | 182,790,000 | 29,487,000 | 78,673,000 | - |
| December, | 105,042,000 | 29,761,000 | 81,826,000 | - |
| Average, | 99,312,000 | 29,440,000 | 83,513,000 | 6,774,000 |

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[1] Not including quantities wasted while cleaning and repairing aqueducts.

TABLE No. 15. — *Statement of Operation of Engines Nos. 1 and 2 at Chestnut Hill High-service Pumping Station for the Year 1909.*

[3 per cent. allowed for slip.]

| MONTH. | ENGINE No. 1. | | | ENGINE No. 2. | | | Total Amount pumped (Million Gallons). | Amount of Coal consumed (Pounds). | Amount of Ashes and Clinkers (Pounds). | Per Cent. of Ashes and Clinkers. | Quantity pumped per Pound of Coal, no Deduction for Heating or Lighting (Gallons). | AVERAGE LIFT (FEET). | | Duty in Foot-pounds per 100 Pounds of Coal, no Deduction for Heating or Lighting; corrected for Slip. | Duty in Foot-pounds per 100 Pounds of Coal, on Basis of Plunger Displacement, no Deduction for Heating or Lighting. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total Pumping Time. | | Amount pumped, corrected for Slip (Million Gallons). | Total Pumping Time. | | Amount pumped, corrected for Slip (Million Gallons). | | | | | | Engine No. 1. | Engine No. 2. | | |
| | Hrs. | Min. | | Hrs. | Min. | | | | | | | | | | |
| January, | 583 | 45 | 207.74 | 101 | 15 | 35.83 | 243.57 | 392,296 | 47,058 | 12.0 | 620.88 | 119.24 | 120.24 | 61,750,000 | 63,670,000 |
| February, | 214 | 10 | 76.94 | 335 | 30 | 113.67 | 190.61 | 281,117 | 24,872 | 8.8 | 678.05 | 120.00 | 121.07 | 68,140,000 | 70,260,000 |
| March, | - | - | - | 589 | 30 | 205.76 | 205.76 | 333,296 | 32,652 | 9.8 | 617.35 | - | 118.83 | 61,110,000 | 63,010,000 |
| April, | 27 | 10 | 9.88 | 317 | 00 | 114.85 | 124.73 | 227,839 | 23,121 | 10.1 | 547.45 | 124.97 | 120.08 | 54,930,000 | 56,640,000 |
| May, | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| June, | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| July, | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| August, | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| September, | 378 | 30 | 123.39 | 209 | 40 | 72.62 | 196.01 | 268,982 | 23,033 | 8.6 | 728.71 | 121.99 | 124.68 | 74,660,000 | 76,980,000 |
| October, | 455 | 50 | 144.86 | - | - | - | 144.86 | 205,510 | 19,230 | 9.4 | 704.88 | 119.22 | - | 70,000,000 | 72,180,000 |
| November, | 237 | 55 | 81.58 | 137 | 05 | 44.60 | 126.18 | 221,391 | 24,887 | 11.2 | 569.94 | 120.80 | 122.17 | 57,580,000 | 59,370,000 |
| December, | 164 | 10 | 55.15 | 110 | 20 | 35.08 | 90.23 | 193,841 | 21,708 | 11.2 | 465.48 | 118.94 | 118.40 | 46,040,000 | 47,470,000 |
| Total, | 2,061 | 30 | 699.54 | 1,800 | 20 | 622.41 | 1,321.95 | 2,124,272 | 216,561 | - | - | - | - | - | - |
| Average, | - | - | - | - | - | - | - | - | - | 10.2 | 622.31 | 120.04 | 120.45 | 62,330,000 | 64,270,000 |

TABLE NO. 16. — *Statement of Operation of Engine No. 3 at Chestnut Hill High-service Pumping Station for the Year 1909.*

[7.5 per cent. allowed for slip.]

| MONTH. | Total Pumping Time. | | Amount pumped, corrected for Slip (Million Gallons). | Amount of Coal consumed (Pounds). | Amount of Ashes and Clinkers (Pounds). | Per Cent. of Ashes and Clinkers. | Quantity pumped per Pound of Coal, no Deduction for Heating or Lighting (Gallons). | Average Lift (Feet). | Duty in Foot-pounds per 100 Pounds of Coal, no Deduction for Heating or Lighting; corrected for Slip. | Duty in Foot-pounds per 100 Pounds of Coal, on Basis of Plunger Displacement, no Deduction for Heating or Lighting. |
|---|---|---|---|---|---|---|---|---|---|---|
| | Hrs. | Min. | | | | | | | | |
| January, | - | - | - | - | - | - | - | - | - | - |
| February, | 33 | 00 | 28.45 | 28,135 | 2,639 | 9.4 | 1,011.20 | 128.21 | 108,000,000 | 116,690,000 |
| March, | 52 | 10 | 42.90 | 46,436 | 4,852 | 10.4 | 923.85 | 126.92 | 97,670,000 | 105,530,000 |
| April, | 202 | 50 | 165.96 | 173,605 | 15,010 | 8.6 | 955.96 | 127.18 | 101,280,000 | 109,430,000 |
| May, | 292 | 40 | 235.29 | 251,995 | 22,338 | 8.9 | 933.71 | 127.15 | 98,890,000 | 106,850,000 |
| June, | 301 | 25 | 245.18 | 283,001 | 24,880 | 8.8 | 866.36 | 128.45 | 92,700,000 | 100,160,000 |
| July, | 306 | 50 | 248.92 | 302,423 | 29,127 | 9.6 | 823.09 | 128.14 | 87,860,000 | 94,930,000 |
| August, | 260 | 45 | 212.03 | 233,915 | 22,069 | 9.4 | 906.44 | 128.66 | 97,150,000 | 104,970,000 |
| September, | 174 | 30 | 143.69 | 154,539 | 13,229 | 8.6 | 929.80 | 128.98 | 99,900,000 | 107,940,000 |
| October, | - | - | - | - | - | - | - | - | - | - |
| November, | 96 | 30 | 79.30 | 87,502 | 8,653 | 9.9 | 906.26 | 124.64 | 94,090,000 | 101,660,000 |
| December, | 3 | 15 | 2.87 | 4,130 | 393 | 9.5 | 694.92 | 126.34 | 73,130,000 | 79,020,000 |
| Total, | 1,723 | 55 | 1,404.59 | 1,565,681 | 143,190 | - | - | - | - | - |
| Average, | - | - | - | - | - | 9.1 | 897.11 | 127.84 | 95,530,000 | 103,220,000 |

## TABLE No. 17. — *Statement of Operation of Engine No. 4 at Chestnut Hill High-service Pumping Station for the Year 1909.*

[3 per cent. allowed for slip.]

| MONTH. | Total Pumping Time. | | Amount pumped, corrected for Slip (Million Gallons). | Amount of Coal consumed (Pounds.) | Amount of Ashes and Clinkers (Pounds). | Per Cent. of Ashes and Clinkers. | Quantity pumped per Pound of Coal, no Deduction for Heating or Lighting (Gallons). | Average Lift (Feet). | Duty in Foot-pounds per 100 Pounds of Coal, no Deduction for Heating or Lighting; corrected for Slip. | Duty in Foot-pounds per 100 Pounds of Coal, on Basis of Plunger Displacement, no Deduction for Heating or Lighting. | SUMMARY OF ENGINES Nos. 1, 2, 3 and 4. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Total Amount pumped, corrected for Slip (Million Gallons). | Daily Average Amount pumped (Million Gallons). |
| | Hrs. | Min. | | | | | | | | | | |
| January, | 740 | 00 | 937.33 | 761,298 | 82,339 | 10.8 | 1,231.23 | 130.73 | 134,080,000 | 138,200,000 | 1,180.90 | 38.094 |
| February, | 665 | 20 | 842.80 | 703,827 | 63,716 | 9.1 | 1,197.44 | 130.55 | 130,220,000 | 134,220,000 | 1,061.86 | 37.924 |
| March, | 740 | 50 | 939.80 | 782,875 | 80,070 | 10.2 | 1,200.44 | 130.61 | 130,610,000 | 134,630,000 | 1,188.46 | 38.338 |
| April, | 692 | 50 | 879.37 | 698,103 | 61,755 | 8.8 | 1,259.66 | 131.29 | 137,760,000 | 142 000,000 | 1,170.06 | 39.002 |
| May, | 735 | 55 | 933.63 | 749,199 | 65,990 | 8.8 | 1,246.17 | 130.04 | 134,990,000 | 139,140,000 | 1,168.92 | 37.707 |
| June, | 708 | 30 | 892.99 | 708,561 | 62,512 | 8.8 | 1,260.29 | 130.20 | 136,690,000 | 140,890,000 | 1,138.17 | 37.939 |
| July, | 740 | 25 | 939.18 | 753,922 | 70,795 | 9.4 | 1,245.73 | 130.64 | 135,560,000 | 139,730,000 | 1,188.10 | 38.326 |
| August, | 742 | 45 | 943.06 | 761,563 | 70,905 | 9.3 | 1,238.32 | 131.78 | 135,930,000 | 140,110,000 | 1,155.09 | 37.261 |
| September, | 597 | 05 | 752.89 | 605,675 | 48,070 | 7.9 | 1,243.06 | 130.16 | 134,780,000 | 138,920,000 | 1,092.59 | 36.420 |
| October, | 740 | 45 | 931.43 | 744,585 | 68,423 | 9.2 | 1,250.94 | 128.66 | 134,070,000 | 138,190,000 | 1,076.29 | 34.719 |
| November, | 621 | 25 | 777.80 | 608,195 | 53,200 | 8.7 | 1,278.87 | 128.73 | 137,140,000 | 141,360,000 | 983.28 | 32.776 |
| December, | 741 | 40 | 938.18 | 747,590 | 78,113 | 10.4 | 1,254.94 | 129.44 | 135,310,000 | 139,470,000 | 1,031.28 | 33.267 |
| Total, | 8,467 | 30 | 10,708.46 | 8,625,393 | 805,888 | - | - | - | - | - | 13,435.00 | - |
| Average, | - | - | - | - | - | 9.3 | 1,241.50 | 130.25 | 134,700,000 | 138,840,000 | - | 36.809 |

### TABLE No. 18. — *Statement of Operation of Engines Nos. 5, 6, and 7, at Chestnut Hill Low-service Pumping Station for the Year 1909.*

[3 per cent. allowed for slip.]

| MONTH. | ENGINE No. 5. | | | ENGINE No. 6. | | | ENGINE No. 7. | | | Total Amount pumped (Million Gallons). | Daily Average Amount pumped (Million Gallons). | Total Amount of Coal consumed (Pounds). | Per Cent. of Ashes and Clinkers. | Quantity pumped per Pound of Coal, no deduction for Heating or Lighting (Gallons). | AVERAGE LIFT (FEET). | | | Duty in Foot-pounds per 100 Pounds of Coal, no Deduction for Heating or Lighting; corrected for Slip. | Duty in Foot-pounds per 100 Pounds of Coal, on Basis of Plunger Displacement, no Deduction for Heating or Lighting. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total Pumping Time. | | Amount pumped, corrected for Slip (Million Gallons). | Total Pumping Time. | | Amount pumped, corrected for Slip (Million Gallons). | Total Pumping Time. | | Amount pumped, corrected for Slip (Million Gallons). | | | | | | Engine No. 5. | Engine No. 6. | Engine No. 7. | | |
| | Hrs | Min. | | Hrs. | Min. | | Hrs. | Min. | | | | | | | | | | | |
| January, . | 735 | 45 | 843.69 | 705 | 15 | 802.80 | 167 | 05 | 229.72 | 1,876.21 | 60.523 | 728,500 | 8.7 | 2,575.44 | 48.07 | 48.34 | 33.66 | 99,590,000 | 102,630,000 |
| February, . | 593 | 35 | 674.19 | 583 | 45 | 662.95 | 206 | 10 | 266.07 | 1,603.21 | 57.258 | 603,990 | 8.0 | 2,654.37 | 47.96 | 48.19 | 37.06 | 102,250,000 | 105,370,000 |
| March, . . | 702 | 35 | 765.57 | 593 | 40 | 624.44 | 203 | 00 | 264.91 | 1,654.92 | 53.385 | 599,562 | 8.8 | 2,760.21 | 45.55 | 46.12 | 28.36 | 98,900,000 | 101,920,000 |
| April, . . | 396 | 00 | 438.92 | 614 | 20 | 721.77 | 306 | 00 | 378.48 | 1,539.17 | 51.306 | 547,215 | 9.9 | 2,812.73 | 50.31 | 46.19 | 29.57 | 101,400,000 | 104,500,000 |
| May, . . | 519 | 05 | 536.78 | 704 | 50 | 785.77 | 246 | 55 | 315.29 | 1,637.84 | 52.834 | 587,135 | 11.1 | 2,789.55 | 49.62 | 47.24 | 31.99 | 104,760,000 | 107,960,000 |
| June, . . | 564 | 25 | 627.26 | 628 | 35 | 710.14 | 239 | 15 | 302.42 | 1,639.82 | 54.661 | 612,172 | 11.6 | 2,678.69 | 51.28 | 50.89 | 32.49 | 106,310,000 | 109,550,000 |
| July, . . | 672 | 00 | 747.51 | 677 | 55 | 755.20 | 183 | 35 | 233.49 | 1,736.20 | 56.006 | 656,580 | 11.0 | 2,644.31 | 52.91 | 52.40 | 33.08 | 110,180,000 | 113,540,000 |
| August, . | 738 | 30 | 797.95 | 622 | 05 | 654.12 | 193 | 50 | 231.84 | 1,683.91 | 54.320 | 646,905 | 9.5 | 2,603.03 | 51.52 | 52.80 | 31.87 | 106,920,000 | 110,180,000 |
| September, . | 621 | 10 | 688.20 | 625 | 55 | 687.12 | 55 | 30 | 68.30 | 1,443.62 | 48.121 | 530,870 | 9.7 | 2,719.35 | 46.16 | 45.89 | 32.67 | 102,830,000 | 105,970,000 |
| October, . | 601 | 05 | 708.15 | 318 | 05 | 359.20 | 398 | 35 | 447.27 | 1,514.62 | 48.859 | 559,500 | 8.9 | 2,707.10 | 46.20 | 48.21 | 35.40 | 98,060,000 | 101,050,000 |
| November, . | 466 | 00 | 531.77 | 496 | 15 | 542.51 | 260 | 05 | 292.46 | 1,366.74 | 45.558 | 507,850 | 9.2 | 2,691.23 | 43.83 | 43.29 | 40.45 | 96,160,000 | 99,090,000 |
| December, . | 169 | 50 | 191.43 | 718 | 40 | 831.14 | 413 | 55 | 464.59 | 1,487.16 | 47.973 | 580,305 | 8.7 | 2,562.72 | 45.04 | 45.40 | 46.80 | 97,750,000 | 100,730,000 |
| Total, . | 6,780 | 00 | 7,551.42 | 7,289 | 20 | 8,137.16 | 2,873 | 55 | 3,494.84 | 19,183.42 | - | 7,160,584 | - | - | - | - | - | - | - |
| Average, | - | - | - | - | - | - | - | - | - | - | 52.557 | - | 9.6 | 2,679.03 | 48.43 | 47.97 | 35.18 | 102,260,000 | 105,380,000 |

## TABLE NO. 19. — *Statement of Operation of Engine No. 8 at Spot Pond Pumping Station for the Year 1909.*

[2 per cent. allowed for slip.]

| MONTH. | Total Pumping Time. | | Amount pumped, corrected for Slip (Million Gallons). | Amount of Coal consumed (Pounds). | Amount of Ashes and Clinkers (Pounds). | Per Cent. of Ashes and Clinkers. | Quantity pumped per Pound of Coal, no Deduction for Heating or Lighting (Gallons). | Average Lift (Feet). | Duty in Foot-pounds per 100 Pounds of Coal, no Deduction for Heating or Lighting; corrected for Slip. | Duty in Foot-pounds per 100 Pounds of Coal, on Basis of Plunger Displacement, no Deduction for Heating or Lighting. |
|---|---|---|---|---|---|---|---|---|---|---|
| | Hrs. | Min. | | | | | | | | |
| January, | 184 | 30 | 79.91 | 82,822 | 7,897 | 9.5 | 964.84 | 119.38 | 95,950,000 | 97,930,000 |
| February, | 35 | 40 | 15.96 | 17,362 | 2,496 | 14.4 | 919.25 | 111.78 | 85,590,000 | 87,350,000 |
| March, | 14 | 00 | 5.93 | 7,127 | 1,025 | 14.4 | 832.05 | 120.76 | 83,700,000 | 85,420,000 |
| April, | - | - | - | - | - | - | - | - | - | - |
| May, | 14 | 30 | 6.16 | 6,320 | 675 | 10.7 | 974.68 | 122.19 | 99,210,000 | 101,250,000 |
| June, | 14 | 45 | 6.14 | 6,591 | 1,005 | 15.2 | 930.95 | 120.20 | 93,210,000 | 95,130,000 |
| July, | - | - | - | - | - | - | - | - | - | - |
| August, | 15 | 00 | 6.44 | 6,725 | 1,000 | 14.9 | 957.16 | 125.53 | 100,090,000 | 102,150,000 |
| September, | - | - | - | - | - | - | - | - | - | - |
| October, | 14 | 30 | 6.58 | 6,536 | 680 | 10.4 | 1,006.73 | 117.47 | 98,510,000 | 100,540,000 |
| November, | 14 | 30 | 6.42 | 6,330 | 700 | 11.1 | 1,014.22 | 115.17 | 97,300,000 | 99,300,000 |
| December, | 12 | 00 | 5.02 | 5,435 | 549 | 10.1 | 923.64 | 121.71 | 93,640,000 | 95,570,000 |
| Total, | 319 | 25 | 138.56 | 145,248 | 16,027 | - | - | - | - | - |
| Average, | - | - | - | - | - | 11.0 | 953.95 | 118.81 | 94,410,000 | 96,350,000 |

TABLE No. 20. — *Statement of Operation of Engine No. 9 at Spot Pond Pumping Station for the Year 1909.*

[3 per cent. allowed for slip.]

| MONTH. | Total Pumping Time. | | Amount pumped, corrected for Slip (Million Gallons). | Amount of Coal consumed (Pounds). | Amount of Ashes and Clinkers (Pounds). | Per Cent. of Ashes and Clinkers. | Quantity pumped per Pound of Coal, no Deduction for Heating or Lighting (Gallons). | Average Lift (Feet). | Duty in Foot-pounds per 100 Pounds of Coal, no Deduction for Heating or Lighting; corrected for Slip. | Duty in Foot-pounds per 100 Pounds of Coal, on Basis of Plunger Displacement, no Deduction for Heating or Lighting. | SUMMARY OF ENGINES NOS. 8 AND 9. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Total Amount pumped corrected for Slip (Million Gallons). | Daily Average Amount pumped (Million Gallons). |
| | Hrs. | Min. | | | | | | | | | | |
| January, | 174 | 55 | 139.43 | 132,643 | 17,993 | 13.6 | 1,051.17 | 129.91 | 113,750,000 | 117,310,000 | 219.34 | 7.075 |
| February, | 225 | 30 | 179.81 | 162,143 | 21,599 | 13.3 | 1,108.96 | 129.85 | 119,950,000 | 123,710,000 | 195.77 | 6.992 |
| March, | 264 | 30 | 208.11 | 190,274 | 25,325 | 13.3 | 1,093.74 | 130.10 | 118,530,000 | 122,240,000 | 214.04 | 6.905 |
| April, | 262 | 05 | 208.27 | 192,503 | 25,668 | 13.3 | 1,081.91 | 130.53 | 117,640,000 | 121,330,000 | 208.27 | 6.942 |
| May, | 272 | 55 | 221.32 | 197,351 | 26,745 | 13.6 | 1,121.45 | 130.80 | 122,190,000 | 126,020,000 | 227.48 | 7.338 |
| June, | 311 | 10 | 255.24 | 215,552 | 29,093 | 13.5 | 1,184.12 | 129.80 | 128,030,000 | 132,040,000 | 261.38 | 8.713 |
| July, | 344 | 15 | 280.13 | 240,597 | 34,916 | 14.5 | 1,164.31 | 130.03 | 126,110,000 | 130,060,000 | 280.13 | 9.036 |
| August, | 310 | 50 | 254.28 | 220,908 | 28,929 | 13.1 | 1,151.07 | 130.93 | 125,540,000 | 129,470,000 | 260.72 | 8.410 |
| September, | 271 | 35 | 216.67 | 192,092 | 24,252 | 12.6 | 1,127.95 | 130.90 | 122,990,000 | 126,840,000 | 216.67 | 7.222 |
| October, | 256 | 30 | 204.75 | 185,016 | 23,294 | 12.6 | 1,106.66 | 130.60 | 120,390,000 | 124,160,000 | 211.33 | 6.817 |
| November, | 239 | 05 | 188.85 | 170,536 | 21,738 | 12.7 | 1,107.39 | 129.96 | 119,880,000 | 123,640,000 | 195.27 | 6.509 |
| December, | 240 | 20 | 198.09 | 180,023 | 23,514 | 13.1 | 1,100.36 | 130.61 | 119,720,000 | 123,470,000 | 203.11 | 6.552 |
| Total, | 3,173 | 40 | 2,554.95 | 2,279,638 | 303,066 | - | - | - | - | - | 2,693.51 | - |
| Average, | - | - | - | - | - | 13.3 | 1,120.77 | 130.35 | 121,690,000 | 125,500,000 | - | 7.379 |

TABLE No. 21. — (*Meter Basis.*) *Average Daily Consumption of Water during the Year 1909, in the Cities and Towns supplied by the Metropolitan Water Works, including Boston, Somerville, Chelsea, Malden, Everett, Quincy, Medford, Melrose, Revere, Watertown, Arlington, Lexington, Milton, Stoneham, Winthrop, Swampscott, Belmont and Nahant. (For Consumption of Water in Whole Metropolitan Water District, see Table No. 24.)*

| MONTH. | Average Daily Consumption (Gallons). | Estimated Population. | Consumption per Inhabitant (Gallons). |
|---|---|---|---|
| January, | 129,656,200 | 953,020 | 136 |
| February, | 126,695,900 | 954,760 | 133 |
| March, | 122,297,500 | 956,500 | 128 |
| April, | 121,656,900 | 958,260 | 127 |
| May, | 120,308,100 | 961,380 | 125 |
| June, | 121,475,500 | 966,510 | 126 |
| July, | 122,695,700 | 969,360 | 127 |
| August, | 119,222,300 | 970,890 | 123 |
| September, | 113,840,000 | 970,920 | 117 |
| October, | 111,327,400 | 970,910 | 115 |
| November, | 108,025,900 | 971,510 | 111 |
| December, | 112,318,600 | 973,460 | 115 |
| For the year, | 119,119,100 | 965,490 | 123 |

**In addition to the above quantities, the United States Government Reservation on Peddocks Island was supplied with 34,632,200 gallons, equivalent to a daily average rate of 94,900 gallons, and a part of Saugus with 5,956,000 gallons, equivalent to a daily average rate of 16,300 gallons.**

TABLE No. 22. — (*Meter Basis.*) *Average Daily Consumption of Water in Gallons, from the Low-service System in 1909.*

| MONTH. | SOUTHERN LOW SERVICE. | NORTHERN LOW SERVICE. | Total Low-service Consumption. |
|---|---|---|---|
| | Boston, excluding East Boston and Charlestown. | Portions of Charlestown, Somerville, Chelsea, Everett, Malden, Medford, East Boston and Arlington. | |
| January, | 54,481,900 | 30,010,800 | 84,492,700 |
| February, | 52,558,900 | 29,427,500 | 81,986,400 |
| March, | 50,468,400 | 26,835,900 | 77,304,300 |
| April, | 49,810,700 | 26,037,300 | 75,848,000 |
| May, | 49,134,800 | 25,599,600 | 74,734,400 |
| June, | 48,529,800 | 26,383,600 | 74,913,400 |
| July, | 47,939,100 | 27,010,800 | 74,949,900 |
| August, | 46,857,900 | 26,615,400 | 73,473,300 |
| September, | 45,039,600 | 25,389,800 | 70,429,400 |
| October, | 44,550,600 | 25,022,400 | 69,573,000 |
| November, | 43,998,000 | 24,579,700 | 68,577,700 |
| December, | 46,838,300 | 25,447,800 | 72,286,100 |
| For the year, | 48,335,600 | 26,531,500 | 74,867,100 |

TABLE No. 23.—(*Meter Basis.*) *Average Daily Consumption of Water, in Gallons, from the High-service and Extra High-service Systems in 1909.*

| MONTH. | SOUTHERN HIGH SERVICE. | SOUTHERN EXTRA HIGH SERVICE. | NORTHERN HIGH SERVICE. | NORTHERN EXTRA HIGH SERVICE. |
|---|---|---|---|---|
| | Quincy, Watertown, Belmont, and Portions of Boston and Milton. | Portions of Boston and Milton. | Revere, Winthrop, Swampscott, Nahant, Stoneham, Melrose, and Portions of Boston, Chelsea, Everett, Malden, Medford and Somerville. | Lexington and Portion of Arlington. |
| January, | 37,191,300 | 500,000 | 6,944,300 | 518,400 |
| February, | 36,725,100 | 468,100 | 6,990,100 | 526,300 |
| March, | 37,081,300 | 534,300 | 6,736,000 | 601,000 |
| April, | 37,647,000 | 579,300 | 6,968,500 | 614,100 |
| May, | 36,822,400 | 583,900 | 7,523,400 | 644,100 |
| June, | 36,555,600 | 644,300 | 8,612,300 | 750,000 |
| July, | 36,916,300 | 777,300 | 9,153,000 | 899,300 |
| August, | 35,839,700 | 659,700 | 8,450,900 | 798,700 |
| September, | 34,752,800 | 534,500 | 7,437,300 | 686,000 |
| October, | 33,794,100 | 511,100 | 6,806,000 | 643,200 |
| November, | 31,888,500 | 532,300 | 6,425,500 | 601,900 |
| December, | 32,357,300 | 531,400 | 6,566,300 | 577,700 |
| For the year, | 35,629,400[1] | 572,500 | 7,398,800[2] | 656,300 |

In addition to the above [1] the United States Government Reservation on Peddocks Island was supplied with a daily average rate of 94,900 gallons, and [2] part of Saugus with a daily average rate of 16,300 gallons.

TABLE No. 24. — *Average Daily Consumption of Water in Cities and Towns supplied from Metropolitan Works, as measured by Venturi Meters in 1909.*

| City or town, | BOSTON. | | SOMERVILLE. | | MALDEN. | | CHELSEA. | | EVERETT. | | QUINCY. | | MEDFORD. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Population supplied, | **632,960.** | | **75,440.** | | **41,280.** | | **33,600.** | | **33,280.** | | **31,440.** | | **21,890.** | |
| MONTH. | GALLONS. | | GALLONS. | | GALLONS. | | GALLONS. | | GALLONS. | | GALLONS. | | GALLONS. | |
| | Per Day. | Per Capita. | Per Day. | Per Capita. | Per Day. | Per Capita. | Per Day. | Per Capita. | Per Day. | Per Capita. | Per Day. | Per Capita. | Per Day. | Per Capita. |
| January, | 104,504,300 | 166 | 6,978,700 | 93 | 1,746,300 | 43 | 3,135,700 | 99 | 2,949,300 | 90 | 2,456,400 | 79 | 1,777,100 | 82 |
| February, | 101,668,500 | 162 | 6,867,000 | 92 | 1,767,700 | 43 | 3,142,200 | 98 | 2,865,400 | 87 | 2,467,500 | 80 | 1,795,000 | 83 |
| March, | 98,043,700 | 156 | 6,585,500 | 87 | 1,684,100 | 41 | 3,013,600 | 94 | 2,671,100 | 81 | 2,604,900 | 84 | 1,750,300 | 81 |
| April, | 97,482,000 | 155 | 6,272,000 | 84 | 1,692,000 | 41 | 2,937,600 | 91 | 2,652,200 | 80 | 2,669,500 | 86 | 1,802,200 | 83 |
| May, | 95,427,900 | 151 | 6,360,700 | 85 | 1,699,600 | 41 | 2,822,400 | 86 | 2,679,100 | 81 | 2,758,400 | 88 | 1,881,900 | 86 |
| June, | 94,428,800 | 149 | 6,499,000 | 86 | 1,940,800 | 47 | 2,886,200 | 87 | 2,793,400 | 84 | 3,048,700 | 97 | 1,896,500 | 87 |
| July, | 93,943,400 | 148 | 6,514,700 | 86 | 2,051,400 | 50 | 2,904,600 | 86 | 2,741,000 | 82 | 3,611,100 | 115 | 1,901,900 | 87 |
| August, | 91,829,200 | 145 | 6,173,700 | 82 | 2,002,600 | 48 | 2,996,400 | 88 | 2,679,300 | 80 | 3,589,000 | 114 | 1,762,400 | 80 |
| September, | 88,971,200 | 140 | 5,967,200 | 79 | 1,912,000 | 46 | 2,731,600 | 79 | 2,511,100 | 75 | 3,148,700 | 100 | 1,693,800 | 77 |
| October, | 87,481,500 | 138 | 6,025,300 | 80 | 1,905,600 | 46 | 2,672,600 | 76 | 2,400,900 | 72 | 3,059,000 | 96 | 1,564,600 | 71 |
| November, | 85,322,900 | 134 | 5,767,600 | 76 | 1,839,800 | 44 | 2,554,200 | 72 | 2,318,100 | 69 | 2,968,500 | 93 | 1,485,500 | 67 |
| December, | 89,606,500 | 141 | 6,021,400 | 79 | 1,769,400 | 43 | 2,653,300 | 73 | 2,445,800 | 73 | 2,616,300 | 82 | 1,475,800 | 67 |
| For the year, | 94,029,900 | 149 | 6,331,000 | 84 | 1,848,500 | 45 | 2,869,400 | 85 | 2,641,300 | 79 | 2,919,000 | 93 | 1,732,300 | 79 |

TABLE NO. 24. — *Average Daily Consumption of Water in Cities and Towns, etc.* — Continued.

| City or town, . . . . . . . | MELROSE. | | REVERE. | | WATERTOWN. | | ARLINGTON. | | MILTON. | | WINTHROP. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Population supplied, . . . . . . | 15,350. | | 14,830. | | 12,630. | | 10,700. | | 7,800. | | 9,140. | |
| MONTH. | GALLONS. | | GALLONS. | | GALLONS. | | GALLONS. | | GALLONS. | | GALLONS. | |
| | Per Day. | Per Capita. | Per Day. | Per Capita. | Per Day. | Per Capita. | Per Day. | Per Capita. | Per Day. | Per Capita. | Per Day. | Per Capita. |
| January, . . . . . . . . | 921,500 | 61 | 1,224,600 | 84 | 736,300 | 59 | 722,200 | 68 | 253,200 | 33 | 840,700 | 93 |
| February, . . . . . . . | 937,200 | 61 | 1,221,000 | 83 | 751,700 | 60 | 716,200 | 68 | 275,800 | 36 | 872,200 | 96 |
| March, . . . . . . . . | 889,200 | 58 | 1,129,300 | 77 | 781,100 | 59 | 742,300 | 70 | 265,100 | 34 | 857,100 | 95 |
| April, . . . . . . . . | 922,800 | 60 | 1,114,500 | 76 | 738,300 | 59 | 755,700 | 71 | 287,900 | 37 | 895,800 | 99 |
| May, . . . . . . . . . | 973,500 | 64 | 1,218,100 | 83 | 770,800 | 61 | 818,800 | 77 | 324,700 | 42 | 986,800 | 108 |
| June, . . . . . . . . | 1,091,600 | 71 | 1,438,800 | 97 | 821,200 | 65 | 981,900 | 92 | 354,700 | 46 | 1,114,800 | 122 |
| July, . . . . . . . . . | 1,095,100 | 71 | 1,523,200 | 103 | 908,200 | 72 | 1,233,200 | 115 | 398,300 | 51 | 1,247,200 | 137 |
| August, . . . . . . . . | 1,018,100 | 66 | 1,515,500 | 102 | 807,800 | 64 | 1,060,800 | 99 | 361,100 | 46 | 1,008,400 | 110 |
| September, . . . . . . . | 974,400 | 63 | 1,324,700 | 89 | 689,100 | 54 | 869,600 | 83 | 333,900 | 43 | 824,800 | 90 |
| October, . . . . . . . . | 940,800 | 61 | 1,132,000 | 76 | 694,600 | 55 | 843,700 | 78 | 336,300 | 48 | 700,000 | 76 |
| November, . . . . . . . | 928,900 | 60 | 1,031,700 | 69 | 688,400 | 54 | 790,800 | 73 | 292,500 | 37 | 629,000 | 68 |
| December, . . . . . . . | 854,300 | 55 | 1,129,300 | 75 | 720,600 | 56 | 760,800 | 71 | 270,300 | 34 | 596,000 | 65 |
| For the year, . . . . . . | 962,300 | 63 | 1,250,700 | 84 | 755,300 | 60 | 861,300 | 81 | 318,200 | 40 | 877,000 | 96 |

TABLE NO. 24. — *Average Daily Consumption of Water in Cities and Towns, etc.* — Concluded.

| City or town, | STONEHAM. | | BELMONT. | | LEXINGTON. | | NAHANT. | | SWAMPSCOTT. | | METROPOLITAN DISTRICT | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Population supplied, | 6,750. | | 5,000. | | 4,870.[1] | | 1,860.[2] | | 6,670.[2] | | 965,490. | |
| MONTH. | GALLONS. | | GALLONS. | | GALLONS. | | GALLONS. | | GALLONS. | | GALLONS. | |
| | Per Day. | Per Capita. | Per Day. | Per Capita. | Per Day. | Per Capita. | Per Day. | Per Capita. | Per Day. | Per Capita. | Per Day. | Per Capita. |
| January, | 552,200 | 83 | 304,100 | 62 | 226,900 | 48 | 56,200 | 60 | 270,500 | 47 | 129,656,200 | 130 |
| February, | 548,400 | 82 | 247,300 | 50 | 246,900 | 52 | 48,700 | 52 | 257,200 | 45 | 126,695,900 | 133 |
| March, | 524,600 | 78 | 265,000 | 53 | 282,800 | 59 | 49,300 | 52 | 258,500 | 45 | 122,297,500 | 128 |
| April, | 489,200 | 73 | 275,800 | 56 | 309,600 | 64 | 59,400 | 56 | 300,900 | 52 | 121,656,900 | 127 |
| May, | 561,400 | 83 | 299,600 | 60 | 331,400 | 69 | 83,800 | 58 | 350,200 | 53 | 120,308,100 | 125 |
| June, | 590,800 | 88 | 385,400 | 77 | 408,300 | 84 | 253,800 | 68 | 545,800 | 70 | 121,475,500 | 126 |
| July, | 657,000 | 97 | 454,400 | 91 | 498,200 | 101 | 310,400 | 75 | 707,400 | 86 | 122,695,700 | 127 |
| August, | 701,400 | 104 | 390,300 | 78 | 439,400 | 90 | 253,200 | 68 | 633,700 | 77 | 119,222,300 | 123 |
| September, | 613,200 | 91 | 292,600 | 58 | 372,100 | 75 | 150,500 | 66 | 440,000 | 57 | 113,840,000 | 117 |
| October, | 545,200 | 80 | 304,500 | 61 | 305,700 | 62 | 84,600 | 65 | 330,500 | 49 | 111,327,400 | 115 |
| November, | 545,400 | 80 | 253,000 | 50 | 275,900 | 55 | 69,300 | 74 | 269,400 | 46 | 108,025,900 | 111 |
| December, | 571,700 | 84 | 239,600 | 47 | 251,900 | 50 | 65,400 | 70 | 270,200 | 46 | 112,318,600 | 115 |
| For the year, | 575,200 | 85 | 310,100 | 62 | 329,400 | 68 | 124,400 | 67 | 388,200 | 58 | 119,119,100 | 123 |

[1] Allowance made for district not supplied.

[2] Allowance for summer population.

TABLE NO. 25. — (*Pump Basis.*) *Consumption of Water in the Metropolitan Water District, as constituted in the Year 1909, and a Small Section of the Town of Saugus, from 1893 to 1909.*

[Gallons per day.]

| MONTH. | 1893. | 1894. | 1895. | 1896. | 1897. | 1898. |
|---|---|---|---|---|---|---|
| January, | 75,209,000 | 67,506,000 | 68,925,000 | 82,946,000 | 85,366,000 | 83,880,000 |
| February, | 71,900,000 | 68,944,000 | 80,375,000 | 87,021,000 | 83,967,000 | 87,475,000 |
| March, | 67,638,000 | 62,710,000 | 69,543,000 | 86,111,000 | 82,751,000 | 85,468,000 |
| April, | 62,309,000 | 57,715,000 | 62,909,000 | 77,529,000 | 79,914,000 | 76,574,000 |
| May, | 61,025,000 | 60,676,000 | 65,194,000 | 73,402,000 | 76,772,000 | 76,677,000 |
| June, | 63,374,000 | 68,329,000 | 69,905,000 | 77,639,000 | 77,952,000 | 83,463,000 |
| July, | 69,343,000 | 73,642,000 | 69,667,000 | 80,000,000 | 85,525,000 | 88,228,000 |
| August, | 66,983,000 | 67,995,000 | 72,233,000 | 78,537,000 | 84,103,000 | 87,558,000 |
| September, | 64,654,000 | 67,137,000 | 73,724,000 | 74,160,000 | 84,296,000 | 88,296,000 |
| October, | 63,770,000 | 62,735,000 | 67,028,000 | 71,762,000 | 79,551,000 | 81,770,000 |
| November, | 61,204,000 | 62,231,000 | 64,881,000 | 71,933,000 | 72,762,000 | 78,177,000 |
| December, | 66,700,000 | 65,108,000 | 70,443,000 | 79,449,000 | 76,594,000 | 86,355,000 |
| Average, | 66,165,000 | 65,382,000 | 69,499,000 | 78,360,000 | 80,793,000 | 83,651,000 |
| Population, | 723,153 | 743,354 | 763,557 | 786,385 | 809,213 | 832,042 |
| Per capita, | 91.5 | 88.0 | 91.0 | 99.7 | 99.8 | 100.5 |

| MONTH. | 1899. | 1900. | 1901. | 1902. | 1903. | 1904. |
|---|---|---|---|---|---|---|
| January, | 96,442,000 | 100,055,000 | 111,275,000 | 118,435,000 | 125,176,000 | 137,771,000 |
| February, | 103,454,000 | 98,945,000 | 117,497,000 | 117,268,000 | 122,728,000 | 143,222,000 |
| March, | 90,200,000 | 97,753,000 | 105,509,000 | 108,461,000 | 111,977,000 | 123,334,000 |
| April, | 86,491,000 | 89,497,000 | 93,317,000 | 103,153,000 | 107,179,000 | 108,688,000 |
| May, | 89,448,000 | 87,780,000 | 95,567,000 | 106,692,000 | 111,589,000 | 111,715,000 |
| June, | 97,691,000 | 98,581,000 | 103,420,000 | 110,002,000 | 105,590,000 | 111,209,000 |
| July, | 96,821,000 | 107,786,000 | 106,905,000 | 108,340,000 | 107,562,000 | 113,584,000 |
| August, | 92,072,000 | 102,717,000 | 102,815,000 | 107,045,000 | 103,570,000 | 112,836,000 |
| September, | 91,478,000 | 103,612,000 | 102,103,000 | 107,752,000 | 106,772,000 | 114,188,000 |
| October, | 89,580,000 | 98,358,000 | 103,389,000 | 106,560,000 | 103,602,000 | 108,290,000 |
| November, | 86,719,000 | 93,648,000 | 101,324,000 | 105,175,000 | 103,477,000 | 108,054,000 |
| December, | 85,840,000 | 97,844,000 | 113,268,000 | 125,434,000 | 114,721,000 | 125,119,000 |
| Average, | 92,111,000 | 98,059,000 | 104,645,000 | 110,345,000 | 110,277,000 | 118,114,000 |
| Population, | 854,870 | 877,698 | 892,740 | 907,780 | 922,820 | 937,860 |
| Per capita, | 107.8 | 111.7 | 117.2 | 121.6 | 119.5 | 125.9 |

TABLE NO. 25. — (*Pump Basis.*) *Consumption of Water, etc.* — Concluded.

[Gallons per day.]

| MONTH. | 1905. | 1906. | 1907. | 1908. | 1909. |
|---|---|---|---|---|---|
| January, | 130,878,000 | 126,093,000 | 137,730,000 | 132,376,000 | 133,275,000 |
| February, | 140,595,000 | 130,766,000 | 150,822,000 | 146,199,000 | 130,763,000 |
| March, | 120,879,000 | 123,570,000 | 134,202,000 | 128,884,000 | 126,842,000 |
| April, | 111,898,000 | 118,428,000 | 121,556,000 | 128,926,000 | 125,335,000 |
| May, | 115,804,000 | 122,404,000 | 123,502,000 | 131,040,000 | 123,305,000 |
| June, | 117,441,000 | 121,882,000 | 125,623,000 | 139,843,000 | 125,179,000 |
| July, | 124,769,000 | 118,726,000 | 128,779,000 | 138,232,000 | 126,765,000 |
| August, | 121,158,000 | 120,591,000 | 131,098,000 | 128,073,000 | 121,781,000 |
| September, | 120,103,000 | 121,685,000 | 124,751,000 | 129,972,000 | 118,043,000 |
| October, | 118,301,000 | 116,561,000 | 124,051,000 | 124,189,000 | 115,939,000 |
| November, | 116,693,000 | 113,746,000 | 119,627,000 | 117,119,000 | 111,664,000 |
| December, | 122,696,000 | 130,995,000 | 122,407,000 | 124,468,000 | 115,733,000 |
| Average, | 121,671,000 | 122,085,000 | 128,561,000 | 130,712,000 | 122,851,000 |
| Population, | 953,556 | 965,990 | 986,680 | 995,010 | 1,022,540 |
| Per capita, | 127.6 | 126.4 | 130.3 | 131.4 | 120.1 |

This table includes the water consumed in the cities and towns enumerated in Table No. 21, together with the water consumed in Newton and Hyde Park, which are included in the Metropolitan Water District, but have not been supplied from the Metropolitan Works. The populations for the years 1901 to 1904 were revised after the census of 1905 became available, and consequently the figures in the reports after 1904 differ from those published in a corresponding table in the preceding annual reports.

## TABLE NO. 26. — *Chemical Examinations of Water from the Wachusett Reservoir, Clinton.*

[Parts per 100,000.]

| Number. | Date of Collection. | APPEARANCE. | | | ODOR. | | RESIDUE ON EVAPORATION. | | AMMONIA. | | | | Chlorine. | NITROGEN AS | | Oxygen Consumed. | Hardness. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | COLOR. | | | | | | ALBUMINOID. | | | | | | | |
| | | Turbidity. | Sediment. | Platinum Standard. | Cold. | Hot. | Total. | Loss on Ignition. | Free. | Total. | Dissolved. | Suspended. | | Nitrates. | Nitrites. | | |
| | **1909.** | | | | | | | | | | | | | | | | |
| 76058 | Jan. 5 | V. slight. | V. slight. | 12 | Faintly vegetable. | Distinctly vegetable. | 2.80 | 1.20 | .0010 | .0120 | .0088 | .0032 | .25 | .0010 | .0000 | .21 | 0.8 |
| 76217 | Jan. 19 | V. slight. | V. slight. | 10 | V. faintly unpleasant. | Faintly unpleasant. | 2.10 | 1.05 | .0012 | .0114 | .0084 | .0030 | .25 | .0010 | .0000 | .17 | 0.6 |
| 76462 | Feb. 2 | V. slight. | V. slight. | 10 | V. faintly unpleasant. | Faintly unpleasant. | 3.60 | 1.65 | .0008 | .0088 | .0074 | .0014 | .24 | .0010 | .0000 | .42 | 1.3 |
| 76674 | Feb. 16 | V. slight. | V. slight. | 11 | Faintly unpleasant. | Distinctly unpleasant. | 4.20 | 2.00 | .0020 | .0140 | - | - | .26 | .0020 | .0000 | .21 | 1.3 |
| 76903 | March 2 | Slight. | Slight. | 11 | Faintly vegetable. | Distinctly vegetable. | 2.40 | 1.05 | .0070 | .0146 | .0124 | .0022 | .19 | .0030 | .0001 | .22 | 1.0 |
| 77061 | March 16 | Slight. | Slight. | 8 | Faintly unpleasant and fishy. | Distinctly unpleasant and fishy. | 2.40 | 1.10 | .0018 | .0152 | .0132 | .0020 | .24 | .0010 | .0000 | .28 | 1.1 |
| 77352 | April 6 | Slight. | Slight. | 10 | V. faintly vegetable. | Faintly fishy. | 2.50 | 1.20 | .0010 | .0102 | .0078 | .0024 | .22 | .0000 | .0000 | .25 | 0.8 |
| 77597 | April 20 | Slight. | Slight. | 11 | Faintly vegetable. | Distinctly vegetable geranium. | 2.20 | 1.10 | .0010 | .0174 | .0106 | .0068 | .23 | .0000 | .0000 | .27 | 1.3 |
| 77795 | May 4 | Slight. | Cons. | 16 | Distinctly geranium asterionella. | Distinctly geranium asterionella. | 2.30 | 1.15 | .0006 | .0142 | .0088 | .0054 | .22 | .0000 | .0000 | .29 | 1.0 |
| 78225 | June 1 | V. slight. | Slight. | 15 | V. faintly vegetable. | Faintly vegetable. | 2.95 | 1.15 | .0008 | .0128 | .0122 | .0006 | .20 | .0000 | .0001 | .30 | 0.5 |
| 78486 | June 16 | V. slight. | V. slight. | 12 | Faintly vegetable. | Distinctly vegetable. | 3.05 | 1.25 | .0044 | .0128 | .0098 | .0030 | .22 | .0000 | .0000 | .27 | 1.3 |
| 78575 | June 22 | V. slight. | V. slight. | 15 | Distinctly gassy. | Distinctly gassy. | 2.60 | 1.00 | .0064 | .0104 | .0098 | .0006 | .20 | .0000 | .0000 | .32 | 1.4 |
| 78858 | July 6 | V. slight. | V. slight. | 15 | None. | V. faintly vegetable. | 2.40 | 1.05 | .0010 | .0142 | .0136 | .0006 | .24 | .0000 | .0002 | .27 | 0.8 |
| 79174 | July 20 | V. slight. | Slight. | 10 | V. faintly vegetable. | V. faintly vegetable. | 2.75 | 1.30 | .0006 | .0100 | .0090 | .0010 | .22 | .0000 | .0000 | .28 | 1.3 |
| 79542 | Aug. 3 | Slight. | Slight. | 14 | None. | V. faintly vegetable. | 3.40 | 1.30 | .0030 | .0106 | .0096 | .0010 | .22 | .0000 | .0000 | .30 | 1.3 |
| 80031 | Aug. 24 | V. slight. | V. slight. | 11 | V. faintly unpleasant. | V. faintly unpleasant. | 2.65 | 1.00 | .0012 | .0136 | .0130 | .0006 | .22 | .0000 | .0000 | .28 | 1.0 |
| 80314 | Sept. 7 | V. slight. | V. slight. | 11 | V. faintly vegetable. | V. faintly vegetable. | 3.55 | 1.35 | .0006 | .0110 | .0092 | .0018 | .22 | .0006 | .0000 | .27 | 1.3 |
| 80664 | Sept. 21 | V. slight. | V. slight. | 13 | V. faintly vegetable. | Faintly vegetable. | 2.40 | 1.00 | .0022 | .0138 | .0118 | .0020 | .21 | .0000 | .0001 | .23 | 1.3 |
| 81052 | Oct. 5 | V. slight. | V. slight. | 11 | V. faintly vegetable. | Faintly vegetable. | 3.15 | 1.10 | .0026 | .0240 | .0196 | .0044 | .22 | .0000 | .0000 | .32 | 1.0 |
| 81409 | Oct. 19 | V. slight. | V. slight. | 11 | Faintly vegetable. | Distinctly vegetable. | 2.95 | 1.35 | .0030 | .0114 | .0102 | .0012 | .23 | .0010 | .0000 | .31 | 0.8 |
| 81727 | Nov. 2 | None. | V. slight. | 10 | Faintly vegetable. | Distinctly vegetable. | 3.10 | 1.50 | .0024 | .0120 | .0104 | .0016 | .22 | .0000 | .0000 | .29 | 1.3 |
| 82008 | Nov. 16 | V. slight. | V. slight. | 11 | Faintly vegetable. | Distinctly vegetable. | 2.40 | 1.10 | .0016 | .0108 | .0098 | .0010 | .23 | .0010 | .0001 | .20 | 0.8 |
| 82447 | Dec. 7 | V. slight. | V. slight. | 8 | V. faintly vegetable and unpleasant. | Faintly vegetable and unpleasant. | 2.75 | 1.25 | .0020 | .0118 | .0092 | .0026 | .22 | .0010 | .0000 | .22 | 1.3 |
| 82755 | Dec. 21 | None. | V. slight. | 16 | Faintly vegetable. | Faintly vegetable. | 2.95 | 1.40 | .0020 | .0110 | - | - | .26 | .0030 | .0000 | .18 | 1.3 |
| Av. | .......... | .......... | .......... | 12 | .......................... | .......................... | 2.81 | 1.23 | .0021 | .0128 | .0102 | .0021 | .23 | .0006 | .0000 | .27 | 1.1 |

TABLE No. 27. — *Chemical Examinations of Water from Sudbury Reservoir.*

[Parts per 100,000.]

| Number. | Date of Collection. | Appearance. | | | Odor. | | Residue on Evaporation. | | Ammonia. | | | | Chlorine. | Nitrogen as | | Oxygen Consumed. | Hardness. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Turbidity. | Sediment. | Color. | Cold. | Hot. | Total. | Loss on Ignition. | Free. | Albuminoid. | | | | Nitrates. | Nitrites. | | |
| | | | | Platinum Standard. | | | | | | Total. | Dissolved. | Suspended. | | | | | |
| | 1909. | | | | | | | | | | | | | | | | |
| 76037 | Jan. 4 | V. slight. | V. slight. | 10 | Faintly vegetable. | Faintly vegetable. | 3.85 | 1.75 | .0008 | .0104 | .0092 | .0012 | .28 | .0010 | .0000 | .18 | 1.0 |
| 76426 | Feb. 1 | V. slight. | V. slight. | 16 | Faintly vegetable. | Distinctly vegetable. | 2.85 | 1.35 | .0016 | .0110 | .0082 | .0028 | .27 | .0020 | .0000 | .23 | 1.3 |
| 76852 | March 1 | V. slight. | Slight. | 11 | Faintly vegetable. | Faintly vegetable. | 2.65 | 1.20 | .0020 | .0114 | .0088 | .0026 | .26 | .0020 | .0000 | .23 | 1.3 |
| 77293 | April 5 | V. slight. | Cons. | 22 | V. faintly vegetable. | Faintly fishy. | 2.90 | 1.25 | .0016 | .0186 | .0136 | .0050 | .25 | .0050 | .0000 | .33 | 1.1 |
| 77746 | May 3 | Slight. | Cons. | 20 | Faintly vegetable, geranium. | Distinctly vegetable. | 3.65 | 1.15 | .0026 | .0178 | .0118 | .0060 | .28 | .0040 | .0002 | .32 | 1.1 |
| 78210 | June 1 | Slight. | Slight. | 22 | Faintly vegetable. | Faintly vegetable and unpleasant. | 3.65 | 1.20 | .0008 | .0156 | .0138 | .0018 | .27 | .0000 | .0004 | .33 | 1.3 |
| 78847 | July 6 | V. slight. | V. slight. | 16 | V. faintly vegetable. | Faintly vegetable. | 3.20 | 1.50 | .0006 | .0148 | .0118 | .0030 | .31 | .0000 | .0002 | .26 | 1.3 |
| 79473 | Aug. 2 | Slight. | Slight. | 14 | V. faintly vegetable. | V. faintly vegetable. | 2.95 | 1.15 | .0038 | .0090 | .0088 | .0002 | .25 | .0000 | .0001 | .22 | 1.3 |
| 80286 | Sept. 7 | Slight. | Slight. | 20 | Faintly vegetable. | Faintly vegetable. | 3.25 | 1.35 | .0044 | .0120 | .0104 | .0016 | - | .0010 | .0002 | .25 | 1.6 |
| 81019 | Oct. 4 | V. slight. | V. slight. | 11 | V. faintly vegetable. | Faintly vegetable. | 2.45 | 1.10 | .0046 | .0140 | .0120 | .0020 | .23 | .0000 | .0000 | .32 | 1.3 |
| 81686 | Nov. 1 | V. slight. | Slight. | 11 | Faintly vegetable and sweetish. | Distinctly vegetable and sweetish. | 2.95 | 1.00 | .0010 | .0132 | .0120 | .0012 | .22 | .0010 | .0000 | .27 | 1.3 |
| 82409 | Dec. 6 | None. | V. slight. | 11 | Faintly vegetable. | Faintly vegetable. | 3.35 | 1.50 | .0020 | .0112 | .0100 | .0012 | .22 | .0000 | .0000 | .22 | 0.8 |
| Av. | ........... | ........... | ........... | 15 | ........................ | ........................ | 3.14 | 1.29 | .0022 | .0133 | .0109 | .0024 | .26 | .0013 | .0001 | .26 | 1.2 |

## TABLE NO. 28. — *Chemical Examinations of Water from Spot Pond, Stoneham.*

[Parts per 100,000.]

| Number. | Date of Collection. | APPEARANCE. | | | ODOR. | | RESIDUE ON EVAPORATION. | | AMMONIA. | | | | Chlorine. | NITROGEN AS | | Oxygen Consumed. | Hardness. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Turbidity. | Sediment. | COLOR. | Cold. | Hot. | Total. | Loss on Ignition. | Free. | ALBUMINOID. | | | | Nitrates. | Nitrites. | | |
| | | | | Platinum Standard. | | | | | | Total. | Dissolved. | Suspended. | | | | | |
| | 1909. | | | | | | | | | | | | | | | | |
| 76047 | Jan. 5 | None. | V. slight. | 11 | V. faintly vegetable. | V. faintly vegetable. | 3.30 | 1.35 | .0020 | .0110 | .0094 | .0016 | .32 | .0000 | .0000 | .19 | 1.3 |
| 76518 | Feb. 8 | None. | V. slight. | 15 | V. faintly vegetable and earthy. | Faintly vegetable and earthy. | 3.70 | 1.70 | .0024 | .0122 | .0104 | .0018 | .29 | .0020 | .0000 | .25 | 1.3 |
| 76875 | March 2 | V. slight. | V. slight. | 10 | Faintly vegetable. | Faintly vegetable. | 3.55 | 1.60 | .0026 | .0150 | .0118 | .0032 | .26 | .0020 | .0000 | .19 | 1.3 |
| 77313 | April 6 | Slight. | Slight. | 8 | V. faintly vegetable. | V. faintly fishy. | 3.65 | 1.10 | .0008 | .0132 | .0104 | .0028 | .29 | .0000 | .0000 | .19 | 1.3 |
| 77741 | May 3 | V. slight. | Slight. | 16 | Faintly vegetable, geranium asterionella. | Distinctly vegetable, geranium asterionella. | 2.70 | 1.15 | .0004 | .0138 | .0106 | .0032 | .34 | .0000 | .0000 | .22 | 1.3 |
| 78262 | June 7 | V. slight. | Slight. | 11 | Faintly vegetable and unpleasant. | Faintly vegetable and unpleasant. | 3.20 | 1.45 | .0008 | .0126 | .0114 | .0012 | .33 | .0000 | .0000 | .24 | 1.3 |
| 78827 | July 6 | V. slight. | V. slight. | 10 | V. faintly vegetable. | Faintly vegetable. | 3.85 | 1.60 | .0016 | .0130 | .0112 | .0018 | .32 | .0000 | .0001 | .12 | 1.3 |
| 79465 | Aug. 2 | Slight. | Slight. | 10 | V. faintly vegetable. | V. faintly vegetable. | 3.60 | 1.60 | .0006 | .0100 | .0094 | .0006 | .34 | .0000 | .0000 | .18 | 1.7 |
| 80283 | Sept. 7 | Slight. | Slight. | 10 | V. faintly vegetable. | Distinctly vegetable. | 3.55 | 1.50 | .0032 | .0168 | .0132 | .0036 | .31 | .0000 | .0000 | .12 | 1.6 |
| 81032 | Oct. 5 | V. slight. | Slight. | 11 | Faintly cucumber. | Distinctly cucumber. | 3.55 | 1.60 | .0018 | .0142 | .0122 | .0020 | .36 | .0000 | .0000 | .20 | 1.3 |
| 81812 | Nov. 8 | None. | None. | 10 | V. faintly vegetable. | Faintly vegetable. | 3.20 | 1.05 | .0008 | .0122 | .0106 | .0016 | .32 | .0010 | .0000 | .27 | 1.3 |
| 82430 | Dec. 7 | V. slight. | V. slight. | 8 | V. faintly unpleasant. | Faintly unpleasant. | 3.45 | 1.10 | .0006 | .0144 | .0114 | .0030 | .33 | .0000 | .0000 | .23 | 1.3 |
| Av. | .......... | .......... | .......... | 11 | ........................ | ........................ | 3.44 | 1.40 | .0015 | .0132 | .0110 | .0022 | .32 | .0004 | .0000 | .20 | 1.4 |

## TABLE No. 29. — *Chemical Examinations of Water from Lake Cochituate.*

[Parts per 100,000.]

| Number. | Date of Collection. | Appearance. | | | Odor. | | Residue on Evaporation. | | Ammonia. | | | | Chlorine. | Nitrogen as | | Oxygen Consumed. | Hardness. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Turbidity. | Sediment. | Color. | Cold. | Hot. | Total. | Loss on Ignition. | Free. | Albuminoid. | | | | Nitrates. | Nitrites. | | |
| | | | | Platinum Standard. | | | | | | Total. | Dissolved. | Suspended. | | | | | |
| | 1909. | | | | | | | | | | | | | | | | |
| 76033 | Jan. 4 | V. slight. | Slight. | 22 | Faintly vegetable. | Faintly vegetable and unpleasant. | 5.95 | 2.20 | .0042 | .0206 | .0160 | .0046 | .57 | .0020 | .0001 | .36 | 2.0 |
| 76420 | Feb. 1 | V. slight. | V. slight. | 17 | Faintly cucumber, Synura. | Distinctly cucumber, Synura. | 5.15 | 2.05 | .0026 | .0196 | .0142 | .0054 | .60 | . 040 | .0000 | .27 | 2.3 |
| 76859 | March 1 | Slight. | Slight. | 27 | Faintly vegetable. | Faintly vegetable and unpleasant. | 5.05 | 2.30 | .0020 | .0174 | .0146 | .0028 | .55 | .0040 | .0000 | .34 | 2.2 |
| 77305 | April 5 | Slight. | Slight. | 22 | Faintly unpleasant. | Faintly unpleasant. | 4.60 | 2.15 | .0008 | .0174 | .0142 | .0032 | .57 | .0030 | .0000 | .38 | 2.2 |
| 77755 | May 3 | V. slight. | Cons. | 22 | Distinctly unpleasant, decaying organisms. | Distinctly unpleasant, decaying organisms. | 6.00 | 2.50 | .0008 | .0210 | .0154 | .0056 | .58 | .0010 | .0001 | .42 | 2.2 |
| 78230 | June 1 | V. slight. | Slight. | 20 | Faintly vegetable. | Faintly vegetable. | 5.40 | 2.10 | .0014 | .0232 | .0188 | .0044 | .56 | .0000 | .0001 | .44 | 2.1 |
| 78833 | July 6 | V. slight. | Slight. | 20 | V. faintly vegetable. | Faintly vegetable. | 6.15 | 2.45 | .0010 | .0216 | .0160 | .0056 | .62 | .0000 | .0002 | .38 | 2.3 |
| 79470 | Aug. 2 | Slight. | Slight. | 20 | V. faintly vegetable. | Faintly vegetable. | 6.05 | 2.45 | .0010 | .0180 | .0160 | .0020 | .64 | .0000 | .0000 | .38 | 1.7 |
| 80301 | Sept. 7 | V. slight. | Slight. | 16 | Faintly vegetable and unpleasant. | Faintly vegetable and unpleasant. | 6.00 | 2.00 | .0020 | .0206 | .0180 | .0026 | .63 | .0000 | .0000 | .43 | 2.2 |
| 81096 | Oct. 6 | V. slight. | V. slight. | 18 | Faintly unpleasant. | Distinctly unpleasant. | 5.40 | 1.85 | .0052 | .0464 | .0364 | .0100 | .58 | .0000 | .0000 | .38 | 2.3 |
| 81683 | Nov. 1 | Slight. | Slight iron. | 20 | Faintly unpleasant. | Distinctly unpleasant. | 6.40 | 2.95 | .0068 | .0230 | .0184 | .0046 | .61 | .0010 | .0001 | .43 | 2.2 |
| 82434 | Dec. 7 | Slight. | Slight.* | 18 | V. faintly unpleasant. | Faintly unpleasant. | 5.80 | 2.00 | .0014 | .0238 | .0160 | .0078 | .60 | .0000 | .0000 | .38 | 2.0 |
| Av. | ........... | ........... | ........... | 20 | ........................ | ........................ | 5.66 | 2.25 | .0024 | .0227 | .0178 | .0049 | .59 | .0013 | .0001 | .38 | 2.1 |

TABLE No. 30. — *Chemical Examinations of Water from a Tap at the State House, Boston.*

[Parts per 100,000.]

| Number. | Date of Collection. | APPEARANCE. |  |  | ODOR. |  | RESIDUE ON EVAPORATION. |  | AMMONIA. |  |  |  | Chlorine. | NITROGEN AS |  | Oxygen Consumed. | Hardness. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  |  | Turbidity. | Sediment. | COLOR. Platinum Standard. | Cold. | Hot. | Total. | Loss on Ignition. | Free. | ALBUMINOID. Total. | Dissolved. | Suspended. |  | Nitrates. | Nitrites. |  |  |
|  | 1909. |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 76025 | Jan. 4 | V. slight. | V. slight. | 14 | Distinctly geranium odor. | Faintly vegetable. | 3.95 | 1.70 | .0010 | .0100 | .0090 | .0010 | .28 | .0030 | .0000 | .18 | 1.0 |
| 76416 | Feb. 1 | V. slight. | Slight. | 20 | Decided geranium, Asterionella. | Decided geranium, Asterionella. | 3.50 | 1.20 | .0016 | .0128 | .0108 | .0020 | .38 | .0060 | .0000 | .17 | 1.7 |
| 76846 | March 1 | V. slight. | V. slight. | 22 | Decided geranium, Asterionella. | Faintly unpleasant. | 3.00 | 1.20 | .0014 | .0116 | .0080 | .0036 | .27 | .0050 | .0000 | .22 | 1.3 |
| 77287 | April 5 | Slight. | Cons. | 22 | Distinctly geranium, Asterionella. | Faintly fishy. | 4.00 | 2.00 | .0016 | .0168 | .0124 | .0044 | .33 | .0100 | .0001 | .27 | 1.3 |
| 77742 | May 3 | V. slight. | Slight. | 25 | Strong geranium, Asterionella. | Distinctly vegetable. | 3.95 | 1.85 | .0068 | .0166 | .0120 | .0046 | .31 | .0050 | .0001 | .32 | 1.3 |
| 78241 | June 2 | Slight. | Slight. | 20 | Faintly geranium. | Faintly vegetable. | 3.70 | 1.75 | .0024 | .0160 | .0138 | .0022 | .29 | .0040 | .0002 | .33 | 1.3 |
| 78822 | July 6 | V. slight. | Slight. | 15 | V. faintly vegetable. | Faintly vegetable. | 3.95 | 1.65 | .0008 | .0124 | .0078 | .0046 | .28 | .0030 | .0001 | .25 | 1.6 |
| 79480 | Aug. 3 | V. slight. | Slight. | 16 | V. faintly vegetable. | Faintly vegetable. | 3.10 | 1.10 | .0002 | .0100 | .0098 | .0002 | .29 | .0000 | .0000 | .29 | 1.3 |
| 80279 | Sept. 7 | Slight. | Slight. | 20 | V. faintly vegetable. | Faintly vegetable. | 3.65 | 1.30 | .0004 | .0140 | .0112 | .0028 | .24 | .0010 | .0000 | .22 | 1.1 |
| 81165 | Oct. 11 | V. slight. | V. slight. | 10 | V. faintly vegetable. | V. faintly vegetable. | 3.20 | 1.15 | .0006 | .0106 | .0100 | .0006 | .27 | .0000 | .0000 | .23 | 1.1 |
| 81655 | Nov. 1 | V. slight. | V. slight. | 17 | Faintly vegetable. | Distinctly vegetable. | 2.55 | 1.20 | .0002 | .0114 | .0094 | .0020 | .24 | .0020 | .0000 | .25 | 1.3 |
| 82398 | Dec. 6 | None. | V. slight. | 10 | Faintly vegetable. | Faintly vegetable and unpleasant. | 3.00 | 1.05 | .0020 | .0110 | .0094 | .0016 | .22 | .0020 | .0000 | .21 | 1.1 |
| Av. | ........... | ........... | ........... | 18 | ........................ | ........................ | 3.46 | 1.43 | .0011 | .0128 | .0103 | .0025 | .28 | .0034 | .0000 | .25 | 1.3 |

TABLE No 31. — *Averages of Examinations of Water from Various Parts of the Metropolitan Water Works in 1909.*

[Parts per 100,000.]

| Locality. | Samples Collected. | Color. | Residue on Evaporation. | | Ammonia. | | | | Chlorine. | Nitrogen as | | Oxygen Consumed. | Hardness. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Albuminoid. | | | | | | | |
| | | Platinum Standard. | Total. | Loss on Ignition. | Free. | Total. | Dis-solved. | Sus-pended. | | Nitrates. | Nitrites. | | |
| Quinepoxet River, Holden, | Semi-monthly, | 39 | 3.68 | 1.50 | .0015 | .0146 | .0130 | .0016 | .29 | .0011 | .0000 | .48 | 1.0 |
| Stillwater River, Sterling, | Semi-monthly, | 32 | 3.57 | 1.47 | .0014 | .0132 | .0112 | .0020 | .20 | .0018 | .0000 | .43 | 1.1 |
| Wachusett Reservoir, West Boylston, | Semi-monthly, | 27 | 3.36 | 1.33 | .0021 | .0131 | .0110 | .0022 | .21 | .0017 | .0001 | .39 | 1.0 |
| Wachusett Reservoir, Clinton, surface, | Semi-monthly, | 12 | 2.81 | 1.23 | .0021 | .0128 | .0102 | .0021 | .23 | .0006 | .0000 | .27 | 1.1 |
| Wachusett Reservoir, Clinton, bottom, | Semi-monthly, | 13 | 2.70 | 1.11 | .0029 | .0107 | .0089 | .0017 | .23 | .0011 | .0000 | .24 | 1.0 |
| Marlborough (Walker's Brook), | Monthly, | 65 | 20.12 | 5.43 | .4362 | .0625 | .0420 | .0206 | 3.20 | .1008 | .0102 | .85 | 7.4 |
| Marlborough Brook filter-beds, effluent,[1] | Monthly, | 8 | 17.28 | – | .0442 | .0096 | – | – | 1.75 | .2740 | .0009 | .25 | 5.5 |
| Wachusett Aqueduct, Southborough,[2] | Monthly, | 15 | 2.74 | 1.11 | .0019 | .0111 | .0094 | .0018 | .23 | .0011 | .0000 | .27 | 1.2 |
| Sudbury Reservoir, surface, | Monthly, | 15 | 3.14 | 1.29 | .0022 | .0133 | .0109 | .0024 | .26 | .0013 | .0001 | .26 | 1.2 |
| Sudbury Reservoir, bottom, | Monthly, | 15 | 3.05 | 1.28 | .0032 | .0136 | .0104 | .0032 | .26 | .0022 | .0001 | .26 | 1.3 |
| Framingham Reservoir, No. 3, inlet, | Monthly, | 14 | 2.78 | 1.17 | .0015 | .0131 | .0104 | .0028 | .25 | .0017 | .0001 | .27 | 1.3 |
| Framingham Reservoir, No. 3, near dam, | Monthly, | 16 | 3.34 | 1.35 | .0028 | .0153 | .0119 | .0034 | .27 | .0014 | .0001 | .28 | 1.2 |
| Hopkinton Reservoir, inlet, | Monthly, | 114 | 5.94 | 2.66 | .0026 | .0287 | .0267 | .0020 | .49 | .0012 | .0001 | 1.29 | 1.7 |
| Hopkinton Reservoir, surface, | Monthly, | 47 | 3.98 | 1.75 | .0016 | .0162 | .0145 | .0016 | .36 | .0018 | .0000 | .60 | 1.2 |
| Hopkinton Reservoir, bottom, | Monthly, | 48 | 4.14 | 1.86 | .0025 | .0147 | .0134 | .0013 | .35 | .0023 | .0001 | .58 | 1.1 |
| Ashland Reservoir, inlet, | Monthly, | 89 | 5.38 | 2.26 | .0024 | .0258 | .0232 | .0025 | .36 | .0058 | .0001 | 1.00 | 1.5 |
| Ashland Reservoir, surface, | Monthly, | 55 | 3.80 | 1.73 | .0020 | .0182 | .0168 | .0014 | .31 | .0013 | .0000 | .68 | 1.2 |
| Ashland Reservoir, bottom,[3] | Monthly, | 55 | 3.72 | 1.56 | .0028 | .0174 | .0154 | .0020 | .30 | .0022 | .0001 | .65 | 1.2 |
| Framingham Reservoir No. 2, inlet, | Monthly, | 66 | 5.14 | 1.99 | .0025 | .0227 | .0200 | .0027 | .40 | .0030 | .0001 | .76 | 1.5 |
| Framingham Reservoir No. 2, near dam, | Monthly, | 65 | 4.87 | 2.12 | .0029 | .0226 | .0196 | .0031 | .37 | .0024 | .0001 | .75 | 1.3 |
| Lake Cochituate, surface, | Monthly, | 20 | 5.66 | 2.25 | .0024 | .0227 | .0178 | .0049 | .59 | .0013 | .0001 | .38 | 2.1 |
| Lake Cochituate, bottom,[3] | Monthly, | 71 | 6.23 | 2.42 | .0341 | .0236 | .0173 | .0063 | .57 | .0019 | .0002 | .50 | 2.4 |
| Dug Pond, | Monthly, | 11 | 4.91 | 1.91 | .0046 | .0187 | .0160 | .0024 | .63 | .0016 | .0001 | .25 | 1.9 |
| Weston Reservoir, | Monthly, | 13 | 3.22 | 1.40 | .0017 | .0131 | .0106 | .0025 | .27 | .0028 | .0001 | .26 | 1.2 |
| Terminal chamber, Sudbury Aqueduct, | Monthly, | 16 | 3.51 | 1.44 | .0016 | .0143 | .0108 | .0035 | .26 | .0016 | .0000 | .26 | 1.2 |
| Spot Pond, | Monthly, | 11 | 3.44 | 1.40 | .0015 | .0132 | .0110 | .0022 | .32 | .0004 | .0000 | .20 | 1.4 |
| Tap in Revere, | Monthly, | 10 | 3.37 | 1.41 | .0008 | .0118 | .0101 | .0017 | .31 | .0008 | .0000 | .22 | 1.3 |
| Tap at State House, | Monthly, | 18 | 3.46 | 1.43 | .0011 | .0128 | .0103 | .0025 | .28 | .0034 | .0000 | .25 | 1.3 |
| Tap in Quincy, | Monthly, | 15 | 3.34 | 1.38 | .0009 | .0108 | .0097 | .0012 | .29 | .0044 | .0000 | .25 | 1.4 |

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[1] Average of 5 samples.

[2] Average of 10 samples.

[3] Average of 11 samples.

TABLE No. 32. — *Chemical Examinations of Water from a Faucet in Boston, from 1892 to 1909.*

[Parts per 100,000.]

| YEAR. | COLOR. | | RESIDUE ON EVAPORATION | | AMMONIA. | | | | Chlorine. | NITROGEN AS | | Oxygen Consumed. | Hardness. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | ALBUMINOID. | | | | | | | |
| | Nessler Standard. | Platinum Standard. | Total. | Loss on Ignition. | Free. | Total. | Dis-solved. | Sus-pended. | | Nitrates. | Nitrites. | | |
| 1892, . . | .37 | 37 | 4.70 | 1.67 | .0007 | .0168 | .0138 | .0030 | .41 | .0210 | .0001 | – | 1.9 |
| 1893, . . | .61 | 53 | 4.54 | 1.84 | .0010 | .0174 | .0147 | .0027 | .38 | .0143 | .0001 | .60 | 1.8 |
| 1894, . . | .69 | 58 | 4.64 | 1.83 | .0006 | .0169 | .0150 | .0019 | .41 | .0106 | .0001 | .63 | 1.7 |
| 1895, . . | .72 | 59 | 4.90 | 2.02 | .0006 | .0197 | .0175 | .0022 | .40 | .0171 | .0001 | .69 | 0.7 |
| 1896, . . | .49 | 45 | 4.29 | 1.67 | .0005 | .0165 | .0142 | .0023 | .37 | .0155 | .0001 | .56 | 1.4 |
| 1897, . . | .65 | 55 | 4.82 | 1.84 | .0009 | .0193 | .0177 | .0016 | .40 | .0137 | .0001 | .64 | 1.6 |
| 1898, . . | .41 | 40 | 4.19 | 1.60 | .0008 | .0152 | .0136 | .0016 | .29 | .0097 | .0001 | .44 | 1.4 |
| 1899, . . | .23 | 28 | 3.70 | 1.30 | .0006 | .0136 | .0122 | .0014 | .24 | .0137 | .0001 | .35 | 1.1 |
| 1900, . . | .24 | 29 | 3.80 | 1.20 | .0012 | .0157 | .0139 | .0018 | .25 | .0076 | .0001 | .38 | 1.3 |
| 1901, . . | .24 | 29 | 4.43 | 1.64 | .0013 | .0158 | .0142 | .0016 | .30 | .0173 | .0001 | .42 | 1.7 |
| 1902, . . | .26 | 30 | 3.93 | 1.56 | .0016 | .0139 | .0119 | .0020 | .29 | .0092 | .0000 | .40 | 1.3 |
| 1903, . . | .25 | 29 | 3.98 | 1.50 | .0013 | .0125 | .0110 | .0015 | .30 | .0142 | .0001 | .39 | 1.5 |
| 1904, . . | – | 23 | 3.93 | 1.59 | .0023 | .0139 | .0121 | .0018 | .34 | .0110 | .0001 | .37 | 1.5 |
| 1905, . . | – | 24 | 3.86 | 1.59 | .0020 | .0145 | .0124 | .0021 | .35 | .0083 | .0001 | .35 | 1.4 |
| 1906, . . | – | 24 | 3.86 | 1.39 | .0018 | .0159 | .0134 | .0025 | .34 | .0054 | .0001 | .36 | 1.3 |
| 1907, . . | – | 22 | 3.83 | 1.40 | .0013 | .0129 | .0109 | .0020 | .33 | .0068 | .0001 | .32 | 1.3 |
| 1908, . . | – | 19 | 3.50 | 1.35 | .0011 | .0115 | .0092 | .0024 | .33 | .0092 | .0001 | .26 | 1.2 |
| 1909, . . | – | 18 | 3.46 | 1.43 | .0011 | .0128 | .0103 | .0025 | .28 | .0034 | .0000 | .25 | 1.3 |

*Note relating to Chemical Examinations of Water, Tables Nos. 26–32.*

The chemical examinations contained in the tables were made by the State Board of Health. Previous to the year 1904 colors were determined by the Nessler standard, but the corresponding values by the platinum standard are also given, for the purpose of comparison with colors determined in the laboratory of the Metropolitan Water and Sewerage Board, as given in subsequent tables. The odor recorded is taken in such a way that it is a much stronger odor than would be noticed in samples drawn directly from a tap or collected directly from a reservoir. The important samples are collected and examined semi-monthly or monthly.

TABLE No. 33. — *Microscopic Organisms in Water from Various Parts of the Metropolitan Water Works, from 1898 to 1909, inclusive.*

[Standard units per cubic centimeter; averages from weekly or biweekly observations.]

| YEAR. | WACHUSETT RESERVOIR. | | SUDBURY RESERVOIR. | | LAKE COCHITUATE. | | FRAMINGHAM RESERVOIR. No. 3. | FRAMINGHAM RESERVOIR. No. 2. | ASHLAND RESERVOIR. | HOPKINTON RESERVOIR. | WHITEHALL RESERVOIR. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Surface. | Bottom. | Surface. | Bottom. | Surface. | Bottom. | Surface. | Mid-depth. | Surface. | Surface. | Surface. |
| 1898, | - | - | 354 | 149 | 830 | 696 | 390 | 245 | 263 | 944 | 690 |
| 1899, | - | - | 470 | 252 | 905 | 644 | 440 | 218 | 357 | 715 | 393 |
| 1900, | - | - | 498 | 361 | 1,758 | 1,071 | 645 | 365 | 390 | 980 | 437 |
| 1901, | - | - | 337 | 225 | 992 | 702 | 336 | 149 | 244 | 450 | 705 |
| 1902, | - | - | 590 | 402 | 1,071 | 730 | 627 | 204 | 550 | 588 | 198 |
| 1903, | - | - | 549 | 388 | 931 | 795 | 459 | 169 | 323 | 231 | 327 |
| 1904, | 313 | - | 517 | 376 | 663 | 542 | 475 | 174 | 153 | 106 | 375 |
| 1905, | 769 | 592 | 644 | 502 | 1,255 | 503 | 535 | 158 | 289 | 240 | 147 |
| 1906, | 446 | 272 | 953 | 714 | 1,407 | 1,143 | 692 | 226 | 431 | 475 | 1,279 |
| 1907, | 425 | 212 | 513 | 419 | 1,123 | 1,200 | 413 | 205 | 378 | 336 | 961 |
| 1908, | 731 | 466 | 850 | 885 | 1,559 | 1,241 | 932 | 725 | 699 | 516 | 708 |
| 1909, | 2,151 | 1,937 | 2,474 | 2,513 | 1,142 | 1,198 | 2,372 | 610 | 608 | 294 | 445 |
| Mean, | 806 | 696 | 729 | 599 | 1,136 | 872 | 698 | 287 | 390 | 490 | 555 |

NOTE. — A large growth of Asterionella originated in the Wachusett Reservoir in 1909, causing the large number of organisms in the water of Sudbury Reservoir and Framingham Reservoir No. 3, Weston and Chestnut Hill reservoirs, Spot Pond and in the water drawn from taps.

TABLE No. 33.—*Microscopic Organisms in Water, etc.*—Concluded.

[Standard units per cubic centimeter; averages from weekly or biweekly observations.]

| YEAR. | WESTON RESERVOIR. | SPOT POND. | CHESTNUT HILL RESERVOIR. |  |  | TAPS. |  |  |  |
|---|---|---|---|---|---|---|---|---|---|
|  |  |  | SUDBURY AQUEDUCT. | COCHITUATE AQUEDUCT. | EFFLUENT GATE-HOUSE. | Southern Low Service. | Southern High Service. | Northern Low Service. | Northern High Service. |
|  | Surface. | Surface. | Inlet. | Inlet. | No. 2. |  |  |  |  |
| 1898, | - | 485 | 304 | 544 | 304 | 230 | - | - | - |
| 1899, | - | 1,129 | 359 | 992 | 329 | 192 | 201 | - | - |
| 1900, | - | 573 | 568 | 1,139 | 897 | 468 | 452 | - | - |
| 1901, | - | 628 | 344 | 697 | 413 | 243 | 280 | - | - |
| 1902, | - | 581 | 563 | 937 | 525 | 367 | 451 | - | - |
| 1903, | - | 650 | 450 | 860 | 435 | 286 | 398 | - | - |
| 1904, | - | 465 | 405 | 838 | 472 | 303 | 470 | 274 | 189 |
| 1905, | - | 609 | 551 | 904 | 554 | 528 | 671 | 363 | 388 |
| 1906, | 783 | 671 | 631 | 1,042 | 721 | 550 | 583 | 326 | 422 |
| 1907, | 443 | 590 | 349 | 909 | 419 | 312 | 427 | 205 | 422 |
| 1908, | 979 | 741 | 783 | 1,073 | 689 | 666 | 695 | 443 | 481 |
| 1909, | 2,399 | 1,079 | 1,999 | 632 | 1,899 | 1,913 | 1,959 | 1,313 | 677 |
| Mean, | 1,151 | 683 | 609 | 881 | 638 | 505 | 599 | 487 | 430 |

NOTE.—A large growth of Asterionella originated in the Wachusett Reservoir in 1909, causing the large number of organisms in the water of Sudbury Reservoir and Framingham Reservoir No. 3, Weston and Chestnut Hill reservoirs, Spot Pond and in the water drawn from taps.

TABLE NO. 34. — *Number of Bacteria per Cubic Centimeter in Water from Various Parts of the Metropolitan Water Works, from 1898 to 1909, inclusive.*

[Averages of weekly determinations.]

| YEAR. | CHESTNUT HILL RESERVOIR. | | | SOUTHERN SERVICE TAPS. | |
|---|---|---|---|---|---|
| | Sudbury Aqueduct Terminal Chamber. | Cochituate Aqueduct. | Effluent Gate-house No. 2. | Low Service, 244 Boylston Street. | High Service, 1 Ashburton Place. |
| 1898, . . . | 207 | 145 | 111 | 96 | - |
| 1899, . . . | 224 | 104 | 217 | 117 | 123 |
| 1900, . . . | 248 | 113 | 256 | 188 | 181 |
| 1901, . . . | 225 | 149 | 169 | 162 | 168 |
| 1902, . . . | 203 | 168 | 121 | 164 | 246 |
| 1903, . . . | 76 | 120 | 96 | 126 | 243 |
| 1904, . . . | 347 | 172 | 220 | 176 | 355 |
| 1905, . . . | 495 | 396 | 489 | 231 | 442 |
| 1906, . . . | 231 | 145 | 246 | 154 | 261 |
| 1907, . . . | 147 | 246 | 118 | 130 | 176 |
| 1908, . . . | 162 | 138 | 137 | 136 | 148 |
| 1909, . . . | 198 | 229 | 119 | 150 | 195 |
| Mean, . . | 230 | 177 | 192 | 153 | 231 |

### TABLE No. 35. — *Colors of Water from Various Parts of the Metropolitan Water Works in 1909. (Means of Weekly Determinations.)*

[Platinum Standard.]

| MONTH. | WACHUSETT RESERVOIR. | | | | | | SUDBURY RESERVOIR. | | | | FRAMINGHAM RESERVOIR. No. 2. | FRAMINGHAM RESERVOIR. No. 3. | LAKE COCHITUATE. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Surface. | Mid-depth. | Bottom. | Worcester Street Bridge. | Quinepoxet River. | Stillwater River. | Surface. | Mid-depth. | Bottom. | End of Open Channel. | Mid-depth. | Mid-depth. | Surface. | Mid-depth. | Bottom. | Influent Streams.[1] |
| January, | 14 | 15 | 15 | 22 | 47 | 36 | 16 | 16 | 16 | 18 | 61 | 16 | 28 | 27 | 27 | 59 |
| February, | 16 | 16 | 17 | 46 | 49 | 45 | 17 | 17 | 18 | 49 | 68 | 20 | 26 | 28 | 28 | 71 |
| March, | 18 | 18 | 18 | 46 | 46 | 42 | 25 | 23 | 24 | 43 | 72 | 25 | 29 | 31 | 33 | 80 |
| April, | 20 | 20 | 20 | 59 | 60 | 55 | 29 | 29 | 30 | 29 | 93 | 30 | 31 | 32 | 34 | 103 |
| May, | 24 | 24 | 24 | 61 | 72 | 65 | 31 | 31 | 31 | 70 | 109 | 33 | 34 | 35 | 36 | 124 |
| June, | 24 | 24 | 25 | 49 | 68 | 62 | 30 | 30 | 31 | 30 | 113 | 31 | 31 | 32 | 82 | 105 |
| July, | 21 | 21 | 22 | 31 | 45 | 42 | 22 | 22 | 24 | 22 | 91 | 22 | 27 | 29 | 70 | 65 |
| August, | 20 | 21 | 23 | 25 | 43 | 32 | 20 | 20 | 27 | 22 | 88 | 21 | 26 | 34 | 211 | 48 |
| September, | 19 | 20 | 23 | 24 | 42 | 28 | 20 | 20 | 31 | 24 | 75 | 19 | 26 | 33 | 235 | 46 |
| October, | 15 | 15 | 18 | 18 | 49 | 31 | 17 | 17 | 18 | 18 | 60 | 17 | 24 | 30 | 271 | 39 |
| November, | 13 | 13 | 13 | 14 | 44 | 28 | 14 | 14 | 14 | 14 | 51 | 14 | 28 | 28 | 60 | 78 |
| December, | 14 | 14 | 14 | 35 | 52 | 44 | 14 | 14 | 14 | 14 | 55 | 14 | 26 | 26 | 29 | 92 |
| Mean, | 18 | 18 | 19 | 36 | 51 | 43 | 21 | 21 | 23 | 29 | 78 | 22 | 28 | 30 | 93 | 76 |

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[1] The colors given in this column represent the combined colors of the waters of the four principal feeders. The color of each is determined monthly, and due weight is given, in combining the results, to the sizes of the streams.

### TABLE No. 35. — *Concluded.*

[Platinum Standard.]

| MONTH. | CHESTNUT HILL RESERVOIR. | | | SPOT POND. | FELLS RESERVOIR. | NORTHERN SERVICE. | | SOUTHERN SERVICE. | |
|---|---|---|---|---|---|---|---|---|---|
| | Inlet (Sudbury Aqueduct). | Inlet (Cochituate Aqueduct). | Effluent Gatehouse No. 2. | Mid-depth. | Effluent Gate-house. | Tap at Glenwood Yard, Medford (Low Service). | Tap at Fire Station, Hancock Street, Everett (High Service). | Tap at 244 Boylston Street, Boston (Low Service). | Tap at 1 Ashburton Place, Boston (High Service). |
| January, | 25 | - | 22 | 14 | 14 | 22 | 14 | 18 | 22 |
| February, | 23 | 27 | 23 | 16 | 16 | 23 | 16 | 21 | 23 |
| March, | 24 | - | 24 | 17 | 17 | 23 | 17 | 22 | 23 |
| April, | 31 | 33 | 30 | 18 | 18 | 30 | 18 | 30 | 30 |
| May, | 31 | - | 30 | 19 | 19 | 30 | 19 | 30 | 30 |
| June, | 32 | 31 | 31 | 18 | 18 | 31 | 18 | 30 | 32 |
| July, | 23 | 28 | 22 | 16 | 16 | 22 | 16 | 22 | 23 |
| August, | 20 | 26 | 21 | 15 | 15 | 21 | 15 | 21 | 21 |
| September, | 20 | 26 | 21 | 16 | 16 | 21 | 16 | 21 | 21 |
| October, | 17 | - | 18 | 14 | 14 | 18 | 14 | 18 | 18 |
| November, | 14 | - | 14 | 12 | 12 | 14 | 12 | 14 | 14 |
| December, | 14 | - | 14 | 11 | 11 | 14 | 12 | 14 | 14 |
| Mean, | 23 | 29 | 23 | 16 | 16 | 22 | 16 | 22 | 23 |

### TABLE No. 36. — *Temperatures of Water from Various Parts of the Metropolitan Water Works in 1909. (Means of Weekly Determinations.)*

**[The temperatures are taken at the same places and times as the samples for microscopical examination; the depth given for each reservoir is the depth from high water mark.]**

**[Degrees Fahrenheit.]**

| MONTH. | WACHUSETT RESERVOIR. | | | SUDBURY RESERVOIR (DEPTH AT PLACE OF OBSERVATION 54.5 FEET). | | | | FRAMINGHAM RESERVOIR NO. 3 (DEPTH AT PLACE OF OBSERVATION 20.5 FEET). | | | LAKE COCHITUATE (DEPTH AT PLACE OF OBSERVATION 62.0 FEET). | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Surface. | Mid-depth. | Bottom. | Surface. | Mid-depth. | Bottom. | End of Open Channel. | Surface. | Mid-depth. | Bottom. | Surface. | Mid-depth. | Bottom. |
| January, . | 33.5 | 33.7 | 34.7 | 34.1 | 36.9 | 38.1 | 33.8 | 34.8 | 34.2 | 35.3 | 36.5 | 35.0 | - |
| February, . | 33.8 | 34.8 | 35.3 | 34.6 | 36.3 | 37.5 | 33.6 | 35.8 | 36.4 | 36.8 | 35.7 | 36.5 | 36.6 |
| March, . | 35.5 | 36.0 | 36.5 | 36.9 | 37.5 | 38.0 | 35.3 | 38.0 | 37.5 | 38.4 | 37.7 | 38.0 | 38.0 |
| April, . . | 42.0 | 42.3 | 42.0 | 46.0 | 45.5 | 44.6 | 43.1 | 47.9 | 48.5 | 47.5 | 46.0 | 45.5 | 43.6 |
| May, . . | 51.5 | 50.3 | 49.5 | 55.7 | 54.1 | 52.3 | 51.8 | 62.0 | 61.3 | 61.0 | 53.8 | 49.7 | 44.2 |
| June, . . | 63.6 | 52.8 | 51.6 | 67.9 | 64.7 | 60.9 | 56.8 | 70.4 | 70.1 | 68.8 | 65.1 | 54.8 | 50.5 |
| July, . . | 69.8 | 56.0 | 53.8 | 72.1 | 69.3 | 65.0 | 58.0 | 73.9 | 73.6 | 73.0 | 73.1 | 55.4 | 50.8 |
| August, . | 71.6 | 61.0 | 54.0 | 72.2 | 68.9 | 65.4 | 58.1 | 72.4 | 72.1 | 71.9 | 71.0 | 53.9 | 48.9 |
| September, . | 66.0 | 63.3 | 54.0 | 65.8 | 65.0 | 64.0 | 60.8 | 66.0 | 65.7 | 65.5 | 64.5 | 54.8 | 48.0 |
| October, . | 58.8 | 58.5 | 54.5 | 57.8 | 57.5 | 57.5 | 54.4 | 56.4 | 56.2 | 55.9 | 57.3 | 53.9 | 48.6 |
| November, . | 48.8 | 49.0 | 49.0 | 47.9 | 48.2 | 48.2 | 47.9 | 44.7 | 44.8 | 44.7 | 46.6 | 46.1 | 45.8 |
| December, . | 37.8 | 38.3 | 38.3 | 35.8 | 36.0 | 36.8 | 37.0 | 34.8 | 34.7 | 34.4 | 35.9 | 36.5 | 36.5 |
| Mean, . | 51.1 | 48.0 | 46.1 | 52.2 | 51.7 | 50.7 | 47.6 | 53.1 | 52.9 | 52.8 | 51.9 | 46.7 | 44.6 |

### TABLE No: 36. — *Concluded.*

[Degrees Fahrenheit.]

| MONTH. | CHESTNUT HILL RESERVOIR. | SPOT POND (DEPTH AT PLACE OF OBSERVATION 28.0 FEET). | | | NORTHERN SERVICE. | | SOUTHERN SERVICE. | |
|---|---|---|---|---|---|---|---|---|
| | Effluent Gatehouse No. 2. | Surface. | Mid-depth. | Bottom. | Tap at Glenwood Yard, Medford (Low Service). | Tap at Fire Station, Hancock Street, Everett (High Service). | Tap at 244 Boylston Street, Boston (Low Service). | Tap at 1 Ashburton Place, Boston (High Service). |
| January, . . . . | 36.6 | 37.6 | 38.1 | 38.5 | 42.5 | 45.0 | 40.5 | 42.5 |
| February, . . . . | 37.7 | 38.1 | 38.9 | 39.3 | 39.6 | 40.8 | 40.4 | 41.1 |
| March, . . . . | 39.4 | 38.5 | 38.5 | 38.8 | 40.8 | 40.8 | 42.3 | 41.6 |
| April, . . . . | 49.2 | 46.1 | 46.1 | 46.1 | 48.0 | 49.3 | 50.6 | 49.7 |
| May, . . . . | 56.1 | 54.3 | 54.1 | 53.4 | 54.8 | 55.3 | 59.7 | 57.8 |
| June, . . . . | 67.3 | 66.8 | 65.5 | 63.3 | 64.4 | 65.1 | 66.5 | 67.7 |
| July, . . . . | 72.5 | 72.4 | 71.9 | 69.9 | 70.9 | 71.0 | 73.4 | 72.5 |
| August, . . . | 72.8 | 73.1 | 73.1 | 71.8 | 71.4 | 71.9 | 72.4 | 72.8 |
| September, . . . | 66.3 | 66.8 | 66.6 | 66.6 | 67.0 | 66.1 | 67.7 | 66.9 |
| October, . . . | 58.8 | 57.9 | 59.4 | 59.3 | 60.8 | 59.8 | 60.5 | 60.4 |
| November, . . . | 46.2 | 46.1 | 46.4 | 46.5 | 51.7 | 50.2 | 52.2 | 49.7 |
| December, . . . | 37.3 | 35.4 | 35.8 | 35.8 | 41.4 | 39.6 | 42.1 | 43.1 |
| Mean, . . . | 53.4 | 52.8 | 52.9 | 52.4 | 54.4 | 54.6 | 55.7 | 55.5 |

TABLE NO. 37. — *Temperatures of the Air at Three Stations on the Metropolitan Water Works in 1909.*

[Degrees Fahrenheit.]

| MONTH. | CHESTNUT HILL RESERVOIR. | | | FRAMINGHAM. | | | CLINTON. | | |
|---|---|---|---|---|---|---|---|---|---|
| | Maximum. | Minimum. | Mean. | Maximum. | Minimum. | Mean. | Maximum. | Minimum. | Mean. |
| January, | 59.0 | —2.0 | 29.4 | 57.0 | —7.0 | 29.2 | 56.0 | —8.0 | 25.7 |
| February, | 58.0 | 0.0 | 31.6 | 57.0 | —4.0 | 31.5 | 53.0 | 0.0 | 27.4 |
| March, | 54.0 | 15.0 | 35.2 | 53.0 | 14.0 | 34.9 | 53.0 | 13.0 | 32.1 |
| April, | 85.0 | 22.0 | 48.6 | 82.0 | 22.0 | 47.8 | 81.0 | 20.0 | 45.3 |
| May, | 82.0 | 33.0 | 56.2 | 83.0 | 32.0 | 56.8 | 82.0 | 35.0 | 55.6 |
| June, | 95.0 | 41.0 | 69.4 | 93.0 | 39.0 | 68.0 | 90.0 | 43.0 | 67.4 |
| July, | 98.0 | 47.0 | 70.9 | 95.0 | 47.0 | 70.1 | 90.0 | 46.0 | 68.4 |
| August, | 98.0 | 41.0 | 71.0 | 94.0 | 40.0 | 67.9 | 90.0 | 35.0 | 65.7 |
| September, | 83.0 | 40.0 | 62.7 | 81.0 | 38.0 | 61.8 | 78.0 | 37.0 | 60.7 |
| October, | 83.0 | 25.0 | 52.6 | 81.0 | 25.0 | 50.6 | 79.0 | 24.0 | 48.5 |
| November, | 74.0 | 22.0 | 45.3 | 75.0 | 18.0 | 44.2 | 75.0 | 17.0 | 42.3 |
| December, | 52.0 | 1.0 | 28.4 | 52.0 | —5.0 | 27.5 | 55.0 | —4.0 | 26.9 |
| Average, | - | - | 50.1 | - | - | 49.2 | - | - | 47.2 |

TABLE NO. 38. — *Table showing Length of Main Lines of Water Pipes and Connections owned and operated by Metropolitan Water and Sewerage Board, and Number of Valves set in Same, Dec. 31, 1909.*

| | DIAMETER OF PIPES IN INCHES. | | | | | | | | | | | | | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 60 | 48 | 42 | 36 | 30 | 24 | 20 | 16 | 14 | 12 | 10 | 8 | 6 | |
| Total length owned and operated January 1, 1909 (feet), | 9,069 | 174,684 | 8,075 | 46,736 | 26,927 | 46,154 | 57,265 | 55,548 | 26 | 19,436 | 598 | 1,128 | 903 | 446,549 |
| Gate valves in same, | - | 45 | - | 41 | 28 | 39 | 37 | 63 | 1 | 74 | 12 | 15 | 17 | 372 |
| Air valves in same, | 5 | 106 | 3 | 35 | 4 | 19 | 34 | 29 | - | 9 | - | - | - | 244 |
| Length laid or relaid during 1909 (feet), | 5,349[1] | 9,980[1] | - | 179 | 591 | 12,858 | 25 | 4,084 | - | 6,626[2] | 3,153[2] | 1 | 26 | 42,872 |
| Gate valves in same, | - | 4 | - | 3 | - | 3 | 2 | 7 | - | 9 | 5 | - | 2 | 35 |
| Air valves in same, | 4 | 5 | - | - | 1 | 7 | - | 1 | - | 1 | 1 | - | - | 20 |
| Length abandoned during 1909 (feet), | - | 83 | - | - | 591 | 8 | 18 | 50 | - | 34 | - | 54 | - | 838 |
| Gate valves in same, | - | - | - | - | - | - | - | - | - | 1 | - | 2 | - | 3 |
| Air valves in same, | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Length owned and operated January 1, 1910 (feet), | 14,418 | 184,581 | 8,075 | 46,915 | 26,927 | 59,004 | 57,272 | 59,582 | 26 | 26,028 | 3,751 | 1,075 | 929 | 488,583[3] |
| Gate valves in same, | - | 49 | - | 44 | 28 | 42 | 39 | 70 | 1 | 82 | 17 | 13 | 19 | 404 |
| Air valves in same, | 9 | 111 | 3 | 35 | 5 | 26 | 34 | 30 | - | 10 | 1 | - | - | 264 |

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[1] Includes 5,349 feet of 60-inch and 907 feet of 48-inch pipe laid but not yet used.
[2] Includes 4,780 feet of 12-inch pipe and 3,140 feet of 10-inch pipe acquired from town of Swampscott.
[3] 92.53 miles.

TABLE NO. 39.—*Statement of Cast-iron Hydrant, Blow-off and Drain Pipes, owned and operated by Metropolitan Water and Sewerage Board, Dec. 31, 1909.*

| | DIAMETER OF PIPES IN INCHES. | | | | | | | | Total. |
|---|---|---|---|---|---|---|---|---|---|
| | **24** | **20** | **16** | **12** | **10** | **8** | **6** | **4** | |
| Total length in use December 31, 1909 (feet), | 352 | 293 | 2,250 | 4,585 | 173 | 315 | 2,828 | 1,262 | 12,058 |
| Total valves in use December 31, 1909, | - | - | 18 | 82 | 1 | 1 | 63 | 41 | 206 |

TABLE No. 40.—*Length of Water Pipes, Four Inches in Diameter and Larger, in the Several Cities and Towns supplied by the Metropolitan Water Works, Dec. 31, 1909.*

| BY WHOM OWNED. | INCHES. | | | | | | | | | | | | | | | | | | | TOTAL. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 60 | 48 | 42 | 40 | 36 | 30 | 28 | 24 | 20 | 18 | 16 | 14 | 12 | 10 | 8 | 7 | 6 | 5 | 4 | Feet. | Miles. |
| Metropolitan Water Works. | 14,418 | 184,531 | 8,075 | - | 46,915 | 26,927 | - | 59,004 | 57,272 | - | 59,082 | 26 | 26,048 | 3,751 | 1,575 | - | 929 | - | - | 488,553 | 92.53 |
| Boston, . . | - | 39,175 | 16,813 | 23,104 | 43,806 | 96,592 | 244 | 77,830 | 95,724 | - | 213,673 | - | 1,237,553 | 184,049 | 643,158 | - | 1,271,466 | - | 65,502 | 4,008,689 | 759.22 |
| Somerville, . . | - | - | - | - | - | - | - | - | 3,596 | 387 | 3,537 | 8,037 | 82,551 | 50,450 | 97,745 | - | 201,215 | - | 20,478 | 467,996 | 88.64 |
| Malden, . . | - | - | - | - | - | - | - | - | - | - | - | 9,152 | 64,576 | 27,144 | 73,988 | - | 207,723 | - | 64,609 | 447,192 | 84.69 |
| Chelsea, . . | - | - | - | - | - | - | - | - | - | - | 7,354 | - | 2,796 | 39,820 | 27,009 | - | 135,170 | - | 8,711 | 220,860 | 41.83 |
| Everett, . . | - | - | - | - | - | - | - | 2,484 | 2,900 | - | 2,233 | 806 | 5,570 | 39,346 | 21,035 | - | 136,732 | - | 30,600 | 241,706 | 45.78 |
| Quincy, . . | - | - | - | - | - | - | - | - | 2,679 | - | 23,232 | - | 26,104 | 37,534 | 95,839 | 994 | 250,321 | 948 | 106,672 | 544,323 | 103.09 |
| Medford, . . | - | - | - | - | - | - | - | - | 673 | - | 6,775 | 9,598 | 26,452 | 37,738 | 74,948 | - | 102,792 | - | 33,311 | 292,287 | 55.35 |
| Melrose, . . | - | - | - | - | - | - | - | - | - | - | 5,223 | 2,920 | 22,986 | 18,728 | 24,249 | - | 127,205 | - | 53,286 | 254,597 | 48.22 |
| Revere,[1] . . | - | - | - | - | - | - | - | - | - | - | 22,650 | 5,760 | 16,136 | 17,050 | 17,355 | - | 53,216 | - | 74,150 | 206,257 | 39.06 |
| Watertown, . . | - | - | - | - | - | - | - | - | - | - | 400 | 11,877 | 5,959 | 4,644 | 19,511 | - | 117,636 | - | 12,666 | 172,693 | 32.71 |
| Arlington, . . | - | - | - | - | - | - | - | - | - | - | - | - | 31,804 | 21,621 | 32,025 | - | 86,779 | - | 22,603 | 194,832 | 36.90 |
| Milton, . . . | - | - | - | - | - | - | - | - | - | - | 103 | 44 | 22,548 | 20,935 | 50,224 | - | 117,584 | - | 15,665 | 227,103 | 43.01 |
| Winthrop, . . | - | - | - | - | - | - | - | - | - | - | - | - | 4,049 | 20,092 | 29,466 | - | 34,324 | - | 64,073 | 152,004 | 28.79 |
| Stoneham, . . | - | - | - | - | - | - | - | - | - | - | - | - | 4,525 | 4,725 | 3,775 | - | 92,950 | - | 13,438 | 119,413 | 22.62 |
| Belmont, . . | - | - | - | - | - | - | - | - | - | - | - | - | 2,389 | 12,702 | 19,719 | - | 79,994 | - | 332 | 115,136 | 21.81 |
| Lexington, . . | - | - | - | - | - | - | - | - | - | - | - | - | 9,000 | 2,664 | 9,360 | - | 72,490 | - | 34,520 | 128,034 | 24.25 |
| Nahant, . . | - | - | - | - | - | - | - | - | - | - | - | - | 150 | 11,550 | 4,800 | - | 32,740 | - | 38,058 | 87,298 | 16.53 |
| Swampscott, . | - | - | - | - | - | - | - | - | - | - | - | - | 7,390 | 14,041 | 9,738 | - | 52,575 | - | 9,110 | 92,854 | 17.59 |
| Total feet, . | 14,418 | 223,706 | 24,888 | 23,104 | 90,721 | 123,519 | 244 | 139,318 | 162,844 | 387 | 344,262 | 48,160 | 1,598,586 | 568,584 | 1,255,519 | 994 | 3,173,841 | 948 | 667,784 | 8,461,827 | - |
| Total miles, . | 2.73 | 42.37 | 4.71 | 4.38 | 17.18 | 23.39 | 0.05 | 26.39 | 30.85 | 0.07 | 65.20 | 9.12 | 302.76 | 107.68 | 237.78 | 0.19 | 601.11 | 0.18 | 126.48 | - | 1,602.62 |

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[1] Including small portion of Saugus.

TABLE No. 41. — *Number of Service Pipes, Meters and Fire Hydrants in the Several Cities and Towns supplied by the Metropolitan Water Works, Dec. 31, 1909, and the Number of Services and Meters installed during the Year 1909.*

| CITY OR TOWN. | Services. | Meters. | Fire Hydrants. | Services Installed. | Meters Installed. |
|---|---|---|---|---|---|
| Boston, | 96,182 | 11,690 | 8,330 | 1,151 | 6,584 |
| Somerville, | 12,018 | 5,147 | 1,056 | 211 | 822 |
| Malden, | 7,303 | 6,978 | 437 | 171 | 147 |
| Chelsea, | 6,613 | 2,212 | 331 | 99 | 847 |
| Everett, | 5,820 | 843 | 525 | 81 | 339 |
| Quincy, | 6,814 | 2,032 | 776 | 365 | 94 |
| Medford, | 4,624 | 2,594 | 530 | 108 | 1,037 |
| Melrose, | 3,510 | 3,510 | 316 | 43 | 194 |
| Revere,[1] | 3,214 | 590 | 177 | 193 | 298 |
| Watertown, | 1,973 | 1,973 | 338 | 54 | 54 |
| Arlington, | 2,032 | 1,121 | 384 | 56 | 129 |
| Milton, | 1,380 | 1,380 | 347 | 52 | 52 |
| Winthrop, | 2,320 | 1,533 | 183 | 103 | 1,126 |
| Stoneham, | 1,447 | 430 | 117 | 31 | 256 |
| Belmont, | 883 | 883 | 171 | 48 | 48 |
| Lexington, | 780 | 362 | 128 | 42 | 117 |
| Nahant, | 398 | 179 | 75 | 8 | 48 |
| Swampscott, | 1,439 | 1,398 | 134 | 47 | 189 |
| Total, | 158,200 | 44,855 | 14,355 | 2,863 | 12,381 |

[1] Includes small portion of Saugus.

TABLE No. 42. — *Average Maximum and Minimum Monthly Heights, in Feet, above Boston City Base, to which Water rose, at Different Stations on the Metropolitan Water Works in 1909.*

| 1909. MONTH. | LOW-SERVICE. | | | | | | | | | | | | | | SOUTHERN HIGH-SERVICE. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | BOSTON ENGINE HOUSE, BULFINCH STREET. | | ALLSTON ENGINE HOUSE, HARVARD STREET. | | MEDFORD, MYSTIC RESERVOIR. | | MEDFORD CITY HALL ANNEX, HIGH STREET. | | SOMERVILLE CITY HALL ANNEX, WALNUT STREET. | | MALDEN WATER WORKS SHOP, GREEN STREET. | | CHELSEA COURT HOUSE. | | BOSTON METROPOLITAN WATER WORKS OFFICE, 1 ASHBURTON PLACE. | | WATERTOWN WATER WORKS OFFICE, MAIN STREET. | |
| | Maximum. | Minimum. | Maximum. | Minimum. | Maximum. | Minimum. | Maximum. | Minimum. | Maximum. | Minimum. | Maximum. | Minimum. | Maximum. | Minimum. | Maximum. | Minimum. | Maximum. | Minimum. |
| January, . | 128 | 118 | 184 | 173 | 167 | 163 | 168 | 165 | 168 | 161 | 165 | 161 | 163 | 153 | 247 | 232 | 264 | 258 |
| February, . | 127 | 116 | 185 | 172 | 167 | 163 | 169 | 165 | 168 | 163 | 165 | 160 | 164 | 153 | 246 | 233 | 264 | 258 |
| March, . | 131 | 121 | 182 | 171 | 167 | 164 | 168 | 165 | 168 | 162 | 165 | 161 | 165 | 154 | 247 | 231 | 264 | 259 |
| April, . . | 135 | 125 | 185 | 172 | 168 | 163 | 166 | 162 | 169 | 162 | 165 | 160 | 166 | 155 | 247 | 232 | 264 | 260 |
| May, . . | 137 | 128 | 183 | 173 | 168 | 164 | 165 | 162 | 168 | 163 | 164 | 161 | 165 | 156 | 247 | 231 | 264 | 256 |
| June, . . | 138 | 127 | 185 | 174 | 168 | 164 | 165 | 162 | 168 | 162 | 165 | 161 | 165 | 155 | 248 | 230 | 262 | 251 |
| July, . . | 137 | 129 | 185 | 174 | 169 | 164 | 165 | 162 | 168 | 161 | 164 | 156 | 166 | 152 | 247 | 232 | 260 | 246 |
| August, . | 141 | 131 | 185 | 174 | 169 | 164 | 165 | 163 | 168 | 162 | 164 | 161 | 165 | 156 | 248 | 234 | 262 | 253 |
| September, . | 141 | 132 | 181 | 172 | 168 | 164 | 165 | 161 | 167 | 162 | 164 | 160 | 164 | 155 | 248 | 234 | 262 | 256 |
| October, . | 141 | 132 | 181 | 173 | 168 | 164 | 168 | 164 | 168 | 164 | 164 | 160 | 165 | 156 | 249 | 234 | 262 | 256 |
| November, . | 144 | 133 | 178 | 170 | 167 | 164 | 169 | 165 | 168 | 163 | 164 | 160 | 166 | 157 | 249 | 234 | 263 | 258 |
| December, . | 136 | 129 | 178 | 167 | 167 | 164 | 169 | 165 | 168 | 162 | 165 | 161 | 165 | 158 | 249 | 236 | 264 | 259 |
| Averages, | 136 | 127 | 183 | 172 | 168 | 164 | 167 | 163 | 168 | 162 | 165 | 160 | 165 | 155 | 248 | 233 | 263 | 256 |

TABLE No. 42. — *Average Maximum and Minimum Monthly Heights, in Feet, above Boston City Base, etc.* — Concluded.

| 1909. MONTH. | SOUTHERN HIGH-SERVICE — Concluded. | | | | | | | | NORTHERN HIGH-SERVICE. | | | | | | | | | | NORTHERN EXTRA HIGH-SERVICE. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | BELMONT WATER WORKS SHOP, WAVERLEY STREET. | | MILTON WATER WORKS OFFICE, ADAMS STREET. | | FORBES HILL TOWER, QUINCY. | | QUINCY WATER WORKS SHOP. | | SOMERVILLE PUMPING STATION, CEDAR STREET. | | MALDEN CITY HALL. | | REVERE WATER WORKS OFFICE, BROADWAY. | | LYNN ENGINE HOUSE, UNION SQUARE. | | WINTHROP WATER WORKS OFFICE, WINTHROP AVENUE. | | LEXINGTON TOWN HALL, MASSACHUSETTS AVENUE. | |
| | Maximum. | Minimum. | Maximum. | Minimum. | Maximum. | Minimum. | Maximum. | Minimum. | Maximum. | Minimum. | Maximum. | Minimum. | Maximum. | Minimum. | Maximum. | Minimum. | Maximum. | Minimum. | Maximum. | Minimum. |
| January, . | 264 | 250 | 246 | 235 | 238 | 230 | 238 | 220 | 272 | 256 | 272 | 266 | 263 | 250 | 259 | 246 | 187 | 150 | 384 | 369 |
| February, . | 264 | 254 | 247 | 235 | 238 | 230 | 238 | 220 | 272 | 257 | 271 | 266 | 262 | 251 | 259 | 248 | 188 | 152 | 377 | 362 |
| March, . | 264 | 253 | 247 | 235 | 238 | 229 | 237 | 218 | 273 | 257 | 271 | 267 | 265 | 252 | 260 | 250 | 189 | 152 | 386 | 371 |
| April, . . | 264 | 252 | 246 | 234 | 237 | 228 | 235 | 216 | 272 | 256 | 272 | 266 | 264 | 251 | 260 | 246 | 189 | 149 | 386 | 368 |
| May, . . | 264 | 250 | 246 | 234 | 235 | 228 | 235 | 214 | 269 | 250 | 270 | 265 | 262 | 243 | 258 | 238 | 187 | 148 | 386 | 366 |
| June, . . | 262 | 243 | 246 | 233 | 236 | 225 | 235 | 209 | 268 | 246 | 267 | 262 | 258 | 226 | 253 | 216 | 184 | 137 | 384 | 358 |
| July, . . | 262 | 238 | 244 | 231 | 235 | 221 | 233 | 202 | 267 | 247 | 267 | 253 | 252 | 207 | 238 | 197 | 190 | 135 | 384 | 351 |
| August, . | 262 | 243 | 244 | 233 | 234 | 223 | 231 | 205 | 267 | 251 | 267 | 261 | 257 | 217 | 252 | 202 | 192 | 145 | 385 | 356 |
| September, | 262 | 250 | 246 | 235 | 235 | 225 | 233 | 210 | 265 | 256 | 268 | 262 | 261 | 239 | 258 | 231 | 192 | 155 | 386 | 366 |
| October, . | 262 | 250 | 248 | 237 | 238 | 227 | 236 | 214 | 264 | 257 | 270 | 263 | 264 | 246 | 261 | 245 | 195 | 157 | 380 | 362 |
| November, | 264 | 255 | 249 | 238 | 237 | 228 | 236 | 215 | 265 | 258 | 271 | 264 | 267 | 250 | 264 | 247 | 197 | 175 | 380 | 366 |
| December, . | 265 | 256 | 248 | 239 | 237 | 230 | 237 | 218 | 272 | 257 | 272 | 264 | 268 | 255 | 265 | 252 | 196 | 174 | 381 | 367 |
| Averages, | 263 | 250 | 246 | 235 | 237 | 227 | 235 | 213 | 269 | 254 | 270 | 263 | 262 | 241 | 257 | 235 | 191 | 152 | 383 | 364 |

# APPENDIX No. 5.

## WATER WORKS STATISTICS FOR THE YEAR 1909.

The Metropolitan Water Works supply the Metropolitan Water District, which includes the following cities and towns: —

| CITY OR TOWN. | Population, Census of 1905. | Estimated Population July 1, 1909. |
|---|---|---|
| Boston, | 595,380 | 632,960 |
| Somerville, | 69,272 | 75,440 |
| Malden, | 38,037 | 41,280 |
| Chelsea, | 37,289 | 33,600 |
| Newton,[1] | 36,827 | 42,600 |
| Everett, | 29,111 | 35,280 |
| Quincy, | 28,076 | 31,440 |
| Medford, | 19,686 | 21,890 |
| Hyde Park,[1] | 14,510 | 15,500 |
| Melrose, | 14,295 | 16,350 |
| Revere, | 12,659 | 14,830 |
| Watertown, | 11,258 | 12,630 |
| Arlington, | 9,668 | 10,700 |
| Milton, | 7,054 | 7,800 |
| Winthrop, | 7,034 | 9,140 |
| Stoneham, | 6,332 | 6,750 |
| Swampscott, | 5,141 | 5,760 |
| Lexington, | 4,530 | 5,370 |
| Belmont, | 4,360 | 5,000 |
| Nahant, | 922 | 940 |
| Total population of Metropolitan Water District, | 951,441 | 1,022,260 |
| Saugus,[2] | 200 | 280 |

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[1] No water supplied to these places during the year from Metropolitan Water Works.

[2] Only a small portion of Saugus is supplied with water.

### *Mode of Supply.*

25 per cent. by gravity.
75 per cent. by pumping.

### *Pumping.*

*Chestnut Hill High-service Station:* —

Builders of pumping machinery, Holly Manufacturing Company, Quintard Iron Works and E. P. Allis Company.

Description of coal used: — Bituminous: New River, Blossburg, Imperial, Vulcan and Logan. Anthracite: Buckwheat. Price per gross ton in bins: bituminous $3.85 to $4.19, buckwheat $2.73. Average price per gross ton $3.70. Per cent. ashes, 9.5.

*Chestnut Hill Low-service Station:* —

Builders of pumping machinery, Holly Manufacturing Company.

Description of coal used: — Bituminous: Vulcan. Anthracite: buckwheat. Price per gross ton in bins: bituminous $3.86 to $4.06, buckwheat $2.61. Average price per gross ton $3.44. Per cent. ashes, 9.6.

*Spot Pond Station:* —

Builders of pumping machinery, Geo. F. Blake Manufacturing Company and Holly Manufacturing Company.

Description of coal used: — Bituminous: Davis. Anthracite: screenings. Price per gross ton in bins: bituminous $4.19 to $4.25, screenings $2.24 to $2.50. Average price per gross ton $3.43. Per cent. ashes, 13.2.

| | Chestnut Hill High-service Station. | | |
|---|---|---|---|
| | Engines Nos. 1 and 2. | Engine No. 3. | Engine No. 4. |
| Daily pumping capacity (gallons), | 16,000,000 | 20,000,000 | 30,000,000 |
| Coal consumed for year (pounds), | 2,124,272 | 1,565,681 | 8,625,393 |
| Cost of pumping, figured on pumping station expenses, | $7,502.01 | $6,528.68 | $32,447.96 |
| Total pumpage for year, corrected for slip (million gallons), | 1,321.95 | 1,404.59 | 10,708.46 |
| Average dynamic head (feet), | 120.04 | 127.84 | 130.25 |
| Gallons pumped per pound of coal, | 622.31 | 897.11 | 1,241.50 |
| Duty on basis of plunger displacement, | 64,270,000 | 103,220,000 | 138,840,000 |
| Cost per million gallons raised to reservoir, | $5.675 | $4.648 | $3.03 |
| Cost per million gallons raised one foot, | .0473 | .0364 | .0233 |

| | CHESTNUT HILL LOW-SERVICE STATION. | SPOT POND STATION. |
|---|---|---|
| | Engine Nos. 5, 6 and 7. | Engines Nos. 8 and 9. |
| Daily pumping capacity (gallons), | 105,000,000 | 30,000,000 |
| Coal consumed for year (pounds), | 7,160,584 | 2,424,886 |
| Cost of pumping, figured on pumping station expenses, | $32,171.73 | $14,048.86 |
| Total pumpage for year, corrected for slip (million gallons), | 19,183.42 | 2,693.51 |
| Average dynamic head (feet), | 45.82 | 129.76 |
| Gallons pumped per pound of coal, | 2,679.03 | 1,110.78 |
| Duty on basis of plunger displacement, | 105,380,000 | 123,760,000 |
| Cost per million gallons raised to reservoir, | $1.677 | $5.216 |
| Cost per million gallons raised one foot, | .0366 | .0402 |

## *Consumption.*

| | |
|---|---|
| Estimated total population of the nineteen cities and towns supplied wholly or partially during the year 1909, | 965,490 |
| Total consumption (gallons), pump basis, | 43,575,790,000 |
| Average daily consumption (gallons), pump basis, | 119,386,000 |
| Gallons per day to each inhabitant, pump basis, | 123.7 |

## *Distribution.*

| | Owned and operated by Metropolitan Water and Sewerage Board. | Total in District supplied by Metropolitan Water Works. |
|---|---|---|
| Kinds of pipe used, | –[1] | –[2] |
| Sizes, | 60 to 6 inch. | 60 to 4 inch. |
| Extensions, less length abandoned (miles), | 7.88 | 33.77 |
| Length in use (miles), | 92.53 | 1,602.62 |
| Stop gates added, | 32 | – |
| Stop gates now in use, | 404 | – |
| Service pipes added, | – | 2,963 |
| Service pipes now in use, | – | 158,200 |
| Meters added, | – | 12,381 |
| Meters now in use, | – | 44,855 |
| Fire hydrants added, | – | 276 |
| Fire hydrants now in use, | – | 14,355 |

[1] Cast-iron and cement-lined wrought iron.

[2] Cast-iron, cement lined wrought-iron and kalamine.

# APPENDIX No. 6.

## CONTRACTS MADE AND PENDING DURING

*Contracts relating to the*

| | 1. Number of Contract. | 2. WORK. | 3. Number of Bids. | Amount of Bid. | | 6. Contractor. |
|---|---|---|---|---|---|---|
| | | | | 4. Next to Lowest. | 5. Lowest. | |
| 1 | 68 | Additions to the pumping plant at Deer Island, Boston Harbor. | 4 | $69,230 00[2] | $51,990 00 | Allis-Chalmers Co., Milwaukee, Wis. |
| 2 | 69[1] | 450 tons, Georges Creek Cumberland Coal for Alewife Brook pumping station. | 5 | $4.60 per ton. | $4.50 per ton.[2] | Locke Coal Co., Malden. |
| 3 | 70[1] | 6,150 tons of coal:—<br>2,250 tons for Deer Island pumping station.<br>3,000 tons for East Boston pumping station.<br>900 tons for Charlestown pumping station. | <br>10<br>7<br>8 | <br>$4.15 per ton.[2]<br>$4.22 per ton.<br>$4.00 per ton. | <br>$3.75 per ton.<br>$3.69 per ton.[2]<br>$3.95 per ton.[2] | Davis Coal and Coke Co., Boston. |
| 4 | 72[1] | Extensions of engine and coal houses at Deer Island, Boston Harbor. | 6 | $37,294 00 | $34,495 00[2] | Walter A. Wentworth Co., Boston. |
| 5 | 73 | Additions to the pumping plant at East Boston. | 1 | - | 37,000 00 | Allis-Chalmers Co., Milwaukee, Wis. |
| 6 | 74 | Extension and repair of engine, boiler and screen houses and new coal house at East Boston. | 6 | 123,722 00 | 110,940 00[2] | Woodbury & Leighton Co., Boston. |
| 7 | 75 | 2,950 tons of coal:—<br>2,500 tons for East Boston pumping station.<br>450 tons for Alewife Brook pumping station. | <br>6<br>3 | <br>$3.96 per ton.<br>$4.30 per ton. | <br>$3.69 per ton.[2]<br>$4.25 per ton.[2] | New England Coal and Coke Co., Boston. |
| 8 | 76 | 3,050 tons of coal:—<br>2,100 tons for Deer Island pumping station.<br>950 tons for Charlestown pumping station. | <br>7<br>6 | <br>$3.85 per ton.<br>$3.65 per ton. | <br>$3.74 per ton.[2]<br>$3.64 per ton.[2] | Staples Coal Co., Boston. |
| 9 | 78 | Additions to the boiler plant at East Boston pumping station. | 6 | $31,933 00[2] | $29,000 00 | Robb-Mumford Boiler Co., South Framingham. |

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[1] Contract completed.

[2] Contract based on this bid.

# APPENDIX No. 6.

THE YEAR 1909 — SEWERAGE WORKS.

*North Metropolitan System.*

| 7. Date of Contract. | 8. Date of Completion of Work. | 9. Prices of Principal Items of Contracts made in 1909. | 10. Value of Work done December 31, 1909. | |
|---|---|---|---|---|
| Nov. 2, 1908, | - | - - | $34,615 00 | 1 |
| July 8, 1908, | June 1, 1909, | - - | 1,762 47 | 2 |
| July 13, 1908, | June 1, 1909, | - - | 24,072 87 | 3 |
| Mar. 8, 1909, | Sept. 13, 1909, | For extensions of the engine and coal houses complete with all appurtenances. | 34,755 56 | 4 |
| June 5, 1909, | - | For furnishing and setting up, complete and ready to operate, one pumping engine actuating vertical shaft and centrifugal pump with connections. | - | 5 |
| Aug. 13, 1909, | - | For extension and repair of engine, boiler and screen houses and for building new coal house complete with all appurtenances. | 8,075 00 | 6 |
| June 18, 1909, | - | $3.69 per ton of 2,240 lbs. delivered in bins at East Boston pumping station.<br>$4.25 per ton of 2,240 lbs. delivered in bins at Alewife Brook pumping station. | 4,175 07 | 7 |
| June 25, 1909, | - | $3.74 per ton of 2,240 lbs. delivered in bins at Deer Island pumping station.<br>$3.64 per ton of 2,240 lbs. delivered in bins at Charlestown pumping station. | 6,334 10 | 8 |
| Dec. 15, 1909, | - | For furnishing and erecting six vertical fire tube boilers on foundations furnished by the Board, with smoke flues and galleries. | - | 9 |

CONTRACTS MADE AND PENDING DURING THE

*Contracts relating to the South*

| | 1. Number of Contract. | 2. WORK. | 3. Number of Bids. | AMOUNT OF BID. | | 6. Contractor. |
|---|---|---|---|---|---|---|
| | | | | 4. Next to Lowest. | 5. Lowest. | |
| 1 | 64[1] | Part of Section 85, Extension of the High-level Sewer, Brighton, 69-inch by 72-inch concrete sewer in tunnel. | 6 | $94,150 00 | $92,400 00[2] | D. F. O'Connell Co., Boston. |
| 2 | 65[1] | Part of Section 85, Extension of the High-level Sewer, Brighton, 69-inch by 72-inch concrete sewer in tunnel. | 3 | 71,400 00 | 67,450 00[2] | Hugh Nawn Contracting Co., Boston. |
| 3 | 67[1] | Section 86, Extension of the High-level Sewer, Brighton, 69-inch by 72-inch and 72-inch by 48-inch concrete sewers, in trench. | 14 | 38,716 00 | 38,054 50[2] | Charles J. Jacobs Co., Boston. |
| 4 | 71[1] | 3,400 tons of coal: —<br>2,400 tons for Ward Street pumping station.<br>500 tons for Quincy pumping station.<br>500 tons for Nut Island screen-house. | <br>8<br>2<br>7 | <br>$4.55 per ton.<br>$4.95 per ton.<br>$4.20 per ton.[2] | <br>$4.41 per ton.[2]<br>$4.45 per ton.[2]<br>$4.15 per ton. | Davis Coal and Coke Co., Boston. |
| 5 | 76 | 2,500 tons of coal: —<br>2,100 tons for Ward Street pumping station.<br>400 tons for Nut Island screen-house. | <br>6<br>7 | <br>$4.14 per ton.<br>$4.10 per ton. | <br>$4.09 per ton.[2]<br>$3.74 per ton.[2] | Staples Coal Co., Boston. |
| 6 | 77 | 400 tons of coal for Quincy pumping station. | 3 | $4.40 per ton. | $4.15 per ton.[2] | Neponset River Coal Co., Dorchester. |

[1] Contract completed.

[2] Contract based on this bid.

YEAR 1909 — SEWERAGE WORKS — *Continued.*

*Metropolitan System.*

| 7. Date of Contract. | 8. Date of Completion of Work. | 9. Prices of Principal Items of Contracts made in 1909. | 10. Value of Work done December 31, 1909. | |
|---|---|---|---|---|
| Nov. 25, 1907, | Feb. 13, 1909, | - - | $92,884 02 | 1 |
| Nov. 25, 1907, | Dec. 9, 1908, | - - | 70,432 00 | 2 |
| Aug. 4, 1908, | Mar. 5, 1909, | - - | 37,423 48 | 3 |
| July 13, 1908, | June 1, 1909, | - - | 11,127 54 | 4 |
| June 25, 1909, | - | $4.09 per ton of 2,240 lbs. delivered in bins at Ward Street pumping station.<br>$3.74 per ton of 2,240 lbs. delivered in bins at Nut Island screen-house. | 3,763 98 | 5 |
| June 30, 1909, | - | $4.15 per ton of 2,240 lbs. delivered in bins at Quincy pumping station. | 431 00 | 6 |

## CONTRACTS MADE AND PENDING DURING THE YEAR 1909 — SEWERAGE WORKS — *Concluded.*

### Summary of Contracts.[1]

| | Value of Work done December 31, 1909. |
|---|---|
| North Metropolitan System, 5 contracts, . . . . . . . . . . . . | $77,445 56 |
| South Metropolitan System, 3 contracts, . . . . . . . . . . . . | 200,739 50 |
| Total of 8 contracts made and pending during the year 1909, . . . . | $278,185 06 |

[1] In this summary the cost of day work and contracts charged to maintenance are excluded.

# APPENDIX NO. 7.

## FINANCIAL STATEMENT PRESENTED TO THE GENERAL COURT ON JANUARY 12, 1910.

The Metropolitan Water and Sewerage Board respectfully presents the following abstract of the account of its doings, receipts, expenditures, disbursements, assets and liabilities for the year ending November 30, 1909, in accordance with the provisions of chapter 235 of the Acts of the year 1906.

### METROPOLITAN WATER WORKS.

### *Construction.*

The loans authorized for expenditures under the Metropolitan Water acts, the receipts which are added to the loan fund, the expenditures for the construction and acquisition of works, and the balance available on December 1, 1909, have been as follows: —

| | | |
|---|---|---|
| Loans authorized under Metropolitan Water acts, | | $41,798,000 00 |
| Receipt from town of Swampscott for admission to Metropolitan Water District, paid into Loan Fund (St. 1909, c. 320), | | 90,000 00 |
| Receipts from the sales of real estate, and from labor, tools and supplies, which are placed to the credit of the Metropolitan Water Loan Fund: — | | |
| For the year ending November 30, 1909, | $5,715 03 | |
| For the period prior to December 1, 1908, | 161,336 53 | |
| | | 167,051 56 |
| | | $42,055,051 56 |
| Amount approved for payment by the Board out of the Metropolitan Water Loan Fund: — | | |
| For the year ending November 30, 1909, | $334,760 00 | |
| For the period prior to December 1, 1908, | 40,666,195 40 | |
| | | 41,000,955 40 |
| Balance December 1, 1909, | | $1,054,096 16 |

The amount of the Metropolitan Water Loans outstanding at the beginning of the fiscal year was $40,500,000. At the end of the year the amount of the loans was $40,898,000. The Metropolitan Water Loan Sinking Fund amounted at the beginning of the year to $6,400,807.56 and at the end of the year to $7,203,406.48. The net decrease in the debt for the Metropolitan Water Works was $404,598.92.

### *Maintenance.*

| | | |
|---|---|---|
| Amount appropriated for the maintenance and operation of works, for the year ending November 30, 1909, | $416,500 | |
| Amount appropriated for the improvement of the Cochituate watershed, | 30,000 | |
| | | $446,500 00 |
| Amount approved by Board for maintenance and operation of works during year ending November 30, 1909, | | 381,350 97 |
| Balance December 1, 1909, | | $65,149 03 |

This balance includes the sum of $30,000 appropriated for the improvement of the Cochituate watershed, which sum has not been expended, as it was deemed necessary to delay the active work upon the improvements until the coming season.

The Board has also received during the year ending November 30, 1909, $11,937.03 from rentals, land products and other sources, which, according to section 18 of the Metropolitan Water Act, are applied by the Treasurer of the Commonwealth to the payment of interest on the Metropolitan Water Loan, to sinking fund requirements, and expenses of maintenance and operation of works, thus reducing the amount of the assessment upon the Metropolitan Water District for the year.

Sums received from sales of water to municipalities not belonging to the District and to water companies, and from municipalities for admission to the District, have been applied as follows: —

| | |
|---|---|
| For the year prior to December 1, 1906, distributed to the cities and towns of the District, as provided by section 3 of the Metropolitan Water Act, | $219,865 65 |
| For the period beginning December 1, 1906, and prior to December 1, 1908, applied to the Metropolitan Water Loan Sinking Fund, as provided by chapter 238 of the Acts of 1907, | 14,076 04 |
| For the year beginning December 1, 1908, and ending November 30, 1909, applied to the Metropolitan Water Loan Sinking Fund, as provided by said last-named act, | 2,775 17 |
| | $236,716 86 |

## METROPOLITAN SEWERAGE WORKS.

### *Construction.*

The loans authorized under the various acts of the Legislature for the construction of the Metropolitan Sewerage Works, the receipts which are added to the proceeds of the loans, and the expenditures for construction, are given below, as follows: —

### NORTH METROPOLITAN SYSTEM.

| | | |
|---|---|---|
| Loans authorized under the various acts, including those for the Revere, Belmont and Malden extensions and North System enlargement and extension, | $6,573,865 73 | |
| Receipts from sales of real estate and from miscellaneous sources, which are placed to the credit of the North Metropolitan System: — | | |
| For the year ending November 30, 1909, | 10,576 01 | |
| For the period prior to December 1, 1908, | 35,731 17 | |
| Amount approved for payment by the Board[1] out of the Metropolitan Sewerage Loan Fund North System: — | | |
| For the year ending November 30, 1909, | - | $137,924 83 |
| For the period prior to December 1, 1908, | - | 6,165,415 67 |
| | $6,620,172 91 | $6,303,340 50 |
| Balance December 1, 1909, | | $316,832 41 |

### SOUTH METROPOLITAN SYSTEM.

| | | |
|---|---|---|
| Loans authorized under the various acts, applied to the construction of the Charles River valley sewer, Neponset valley sewer, High-level Sewer and Extension, | $8,867,046 27 | |
| Receipts for pumping, sales of real estate and from miscellaneous sources, which are placed to the credit of the South Metropolitan System: — | | |
| For the year ending November 30, 1909, | 325 10 | |
| For the period prior to December 1, 1908, | 11,081 72 | |
| Amount approved by the Board for payment as follows: — | | |
| On account of the Charles River valley sewer, | | $800,046 27 |
| On account of the Neponset valley sewer, | | 911,531 46 |
| On account of the High-level Sewer and Extension: — | | |
| For the year ending November 30, 1909, | | 64,341 63 |
| For the period prior to December 1, 1908, | | 7,007,590 02 |
| | $8,878,453 09 | $8,783,509 38 |
| Balance December 1, 1909, | | $94,943 71 |

The loans for the Metropolitan Sewerage Works outstanding at the beginning of the fiscal year amounted to $15,027,912, and at the end of the year to $15,327,912. The amount of the Metropolitan Sewerage Sinking Fund was at the beginning of the fiscal year $1,491,275.67, and at the end of the year was $1,672,017.97. The net debt accordingly increased from $13,536,636.33 to $13,655,894.03, a total increase of $119,257.70.

## *Maintenance.*

### NORTH METROPOLITAN SYSTEM.

| | |
|---|---|
| Appropriated for the year ending November 30, 1909, | $146,900 00 |
| Appropriated in the year 1908 for the restoration and equipment of the East Boston pumping station, injured by fire ($40,000), remaining, | 17,284 43 |
| Receipts from pumping and from other sources, which are returned to the appropriation: — | |
| For the year ending November 30, 1909, | 1,582 12 |
| | $165,766 55 |
| Amount approved for payment by the Board: — | |
| For the year ending November 30, 1909, | 144,195 03 |
| Balance December 1, 1909, | $21,571 52 |

---

[1] The word "Board" refers to the Metropolitan Sewerage Commission and the Metropolitan Water and Sewerage Board.

This balance of $21,571.52 includes the sum of $13,884.43 which still remains out of the special appropriation for the restoration and equipment of the East Boston pumping station, which have not yet been completed. The general balance remaining is consequently $7,687.09.

### SOUTH METROPOLITAN SYSTEM.

| | |
|---|---|
| Appropriated for the year ending November 30, 1909, | $105,700 00 |
| Receipts from sales of property and for pumping, which are returned to the appropriation: — | |
| For the year ending November 30, 1909, | 255 54 |
| | $105,955 54 |
| Amount approved for payment by the Board: — | |
| For the year ending November 30, 1909, | 96,538 50 |
| Balance December 1, 1909, | $9,417 04 |

# APPENDIX NO. 8.

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## LEGISLATION OF THE YEAR 1909 AFFECTING THE METROPOLITAN WATER AND SEWERAGE BOARD.

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### ACTS OF 1909.

[CHAPTER 74.]

### AN ACT TO EXEMPT THE TOWNS OF HINGHAM AND HULL FROM CERTAIN PROVISIONS OF LAW RELATIVE TO THE METROPOLITAN WATER SYSTEM.

*Be it enacted, etc., as follows:*

**1895, 488, § 23, amended. (Hingham and Hull exempted.)**

SECTION 1. Section twenty-three of chapter four hundred and eighty-eight of the acts of the year eighteen hundred and ninety-five is hereby amended by inserting after the word "town", in the first line, the words: — except the towns of Hingham and Hull, — so as to read as follows: — *Section 23.* No city or town, except the towns of Hingham and Hull, any part of which is within ten miles of the state house, or any water company owning a water pipe system in any such city or town shall, except in case of emergency, use, for domestic purposes water from any source not now used by it except as herein provided or as shall be hereafter authorized by the legislature. If any town or towns in said district shall take the franchise, works and property in such town or towns, of any water company, the compensation to be allowed and paid therefor shall not be increased or decreased by reason of the provisions of this act. No town in said water district now supplied with water by a water company owning the water pipe system in such town, shall introduce water from the metropolitan water works until it shall first have acquired the works of such company.

**Not to affect certain rights, etc.**

SECTION 2. This act shall be given effect as if the exception were originally a part of said section twenty-three of chapter four hundred and eighty-eight of the acts of the year eighteen hundred and ninety-five, except that it shall not be construed as affecting the provisions of chapter three hundred and thirty-six of the acts of the year eighteen hundred and ninety-seven, so far as the same apply to said towns of Hingham and Hull, and shall not be so construed as to affect the rights of any third party for damages for any taking made prior to the passage of this act.

SECTION 3. This act shall take effect upon its passage. [*Approved February 18, 1909.*

[CHAPTER 90.]

## AN ACT MAKING APPROPRIATIONS FOR THE MAINTENANCE AND IMPROVEMENT OF THE METROPOLITAN WATER SYSTEM.

*Be it enacted, etc., as follows:*

**Appropriation for maintenance of metropolitan water works.**

SECTION 1. The sums hereinafter mentioned are appropriated, to be paid out of the Metropolitan Water Maintenance Fund, for the maintenance and operation of the metropolitan water system for the cities and towns in what is known as the metropolitan water district, during the fiscal year ending on the thirtieth day of November, nineteen hundred and nine, to wit: —

For the maintenance and operation of the metropolitan water system, a sum not exceeding four hundred and sixteen thousand five hundred dollars.

For the improvement of the Cochituate watershed, a sum not exceeding thirty thousand dollars.

SECTION 2. This act shall take effect upon its passage. [*Approved February 25, 1909.*

[CHAPTER 104.]

## AN ACT MAKING AN APPROPRIATION FOR OPERATING THE SOUTH METROPOLITAN SYSTEM OF SEWAGE DISPOSAL.

*Be it enacted, etc., as follows:*

**Appropriation for maintenance of south metropolitan sewerage system.**

SECTION 1. A sum not exceeding one hundred and five thousand seven hundred dollars is hereby appropriated, to be paid out of the South Metropolitan System Maintenance *Fund,* for the cost of maintenance and operation of the south metropolitan system of sewage disposal, comprising a part of Boston, the cities of Newton, Quincy and Waltham, and the towns of Brookline, Watertown, Dedham, Hyde Park and Milton, during the fiscal year ending on the thirtieth day of November, nineteen hundred and nine.

SECTION 2. This act shall take effect upon its passage. [*Approved February 26, 1909.*

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[CHAPTER 105.]

## AN ACT MAKING AN APPROPRIATION FOR OPERATING THE NORTH METROPOLITAN SYSTEM OF SEWAGE DISPOSAL.

*Be it enacted, etc., as follows:*

Appropriation for maintenance of north metropolitan sewerage system.

SECTION 1. A sum not exceeding one hundred and forty-six thousand nine hundred dollars is hereby appropriated, to be paid out of the North Metropolitan System Maintenance Fund, for the maintenance and operation of the system of sewage disposal for the cities and towns included in what is known as the north metropolitan system, during the fiscal year ending on the thirtieth day of November, nineteen hundred and nine.

SECTION 2. This act shall take effect upon its passage. [*Approved February 26, 1909.*

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[CHAPTER 177.]

## AN ACT RELATIVE TO THE USE AND CARE OF WATER METERS IN THE CITIES AND TOWNS OF THE METROPOLITAN WATER DISTRICT.

*Be it enacted, etc., as follows:*

1907, 524, § 3, amended.

SECTION 1. Section three of chapter five hundred and twenty-four of the acts of the year nineteen hundred and seven is hereby amended by striking out the last sentence and inserting in place thereof the following: — It shall be the duty of the metropolitan water and sewerage board to supervise and promote the enforcement of the provisions of this act, and if any city, town, district or corporation violates or neglects in any respect to comply with the provisions hereof, said board shall forthwith give written notice of such violation or neglect, together with the facts relative thereto, to the attorney-general for his action in the premises. The supreme judicial court shall have jurisdiction, upon an information

Metropolitan water and sewerage board to supervise and enforce provisions of water meter act.

in equity filed by the attorney-general, to enforce all the terms and provisions of this act, — so as to read as follows: — *Section 3.* Meters shall receive the necessary care and maintenance to secure proper efficiency and shall be tested or replaced by the city, town, district or water company whenever there is reason to believe that the records furnished by them are inaccurate, or whenever the service furnished is in other respects inefficient. Cities, towns, districts and corporations may make rules and regulations relative to the care, maintenance and protection of meters, and for properly ascertaining and recording the amount of water actually used during specified periods by each water consumer. It shall be the duty of the metropolitan water and sewerage board to supervise and promote the enforcement of the provisions of this act, and if any city, town, district or corporation violates or neglects in any respect to comply with the provisions hereof, said board shall forthwith give written notice of such violation or neglect, together with the facts relative thereto, to the attorney-general for his action in the premises. The supreme judicial court shall have jurisdiction, upon an information in equity filed by the attorney-general, to enforce all the terms and provisions of this act.

**(Care and maintenance of water meters, etc.)**

**1907, 524, § 4, amended.**

SECTION 2. Said chapter five hundred and twenty-four is hereby further amended by striking out section four and inserting in place thereof the following: — *Section 4.* If a city, town, district or corporation in any year neglects or refuses to comply with the provisions of section one, it shall forfeit to the commonwealth for the use of the metropolitan water district not less than twenty dollars and not more than one hundred dollars for each day after the expiration of said year during which such violation or neglect continues. The penalties or forfeitures which may be incurred hereunder may be recovered in an action of contract brought in the county of Suffolk in the name of the commonwealth, or may be recovered by an information in equity in the name of the attorney-general at the relation of the metropolitan water and sewerage board, brought in the supreme judicial court for the county of Suffolk.

**Penalties for refusal to install water meters.**

**When to take effect.**

SECTION 3. Section one of this act shall take effect upon its passage, and section two shall take effect on the first day of January, nineteen hundred and ten. [*Approved March 18, 1909.*

[CHAPTER 243.]

### AN ACT RELATIVE TO PAYMENTS IN LIEU OF TAXES ON PROPERTY HELD BY THE COMMONWEALTH FOR WATER SUPPLY PURPOSES.

*Be it enacted, etc., as follows:*

**Provisions of law relative to payment in lieu of taxes to apply to land held for metropolitan water supply.**

SECTION 1. All general laws relating to annual payments in lieu of taxes on property held by a city or town in another city or town for water supply purposes shall, so far as they are applicable, apply to the metropolitan water supply and to the lands held by the commonwealth and used by the metropolitan water and sewerage board for such supply in cities and towns other than the towns of Ashland, Boylston, Holden, Hopkinton, Sterling and West Boylston.

SECTION 2. This act shall take effect upon its passage. [*Approved March 31, 1909.*

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[CHAPTER 258.]

### AN ACT TO AUTHORIZE THE METROPOLITAN WATER AND SEWERAGE BOARD TO SUPPLY WATER TO SECTIONS OF CITIES AND TOWNS NOT INCLUDED IN THE METROPOLITAN WATER DISTRICT.

*Be it enacted, etc., as follows:*

**1902, 189, § 1, amended. (Including city or town.)**

SECTION 1. Section one of chapter one hundred and eighty-nine of the acts of the year nineteen hundred and two is hereby amended by inserting after the word "any", in the second line, the words: — city, town or, — and by inserting after the word "the", in the eighth line, the words: — city, town or, — so as to read as follows: — *Section 1.* The metropolitan water and sewerage board may from time to time furnish water to any city, town or water company which owns the water pipe system in a section of a city or town, for the supply of such section, although the city or town, or a part of the city or town, is within ten miles of the state house, and the city or town has not been admitted into the metropolitan water district, on payment by the city, town or water company of such sum of money as the said board may determine: *provided, however,* that the sum so determined in any case shall in the opinion of the board exceed the proper proportion

**Metropolitan water and sewerage board may furnish water under certain conditions.**

**Proviso.**

of the entire assessment which would be imposed upon the city or town were it a part of the metropolitan district.

SECTION 2. This act shall take effect upon its passage. [*Approved April 2, 1909.*

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[CHAPTER 282.]

### AN ACT TO EXCLUDE DUG POND IN THE TOWN OF NATICK FROM THE METROPOLITAN WATER SYSTEM.

*Be it enacted, etc., as follows:*

**Dug pond in Natick excluded from the metropolitan water system.**

SECTION 1. The metropolitan water and sewerage board may close and terminate the existing connection between Lake Cochituate and Dug pond in the town of Natick, and transfer and release to the town of Natick all interest in and control over the waters of the said pond. Thereafter Dug pond shall not be used as a source of water supply by the metropolitan water district or by any city or town, nor shall it be allowed to overflow into Lake Cochituate or be connected with the water supply of said district or of any city or town; and said pond shall be subject to the control and regulation of the park commissioners of the town of Natick, who are hereby authorized to impose penalties for the violation of any regulations made by them in respect to the said pond.

SECTION 2. This act shall take effect upon its passage. [*Approved April 9, 1909.*

---

[CHAPTER 320.]

### AN ACT TO AUTHORIZE THE METROPOLITAN WATER AND SEWERAGE BOARD TO MAKE CERTAIN IMPROVEMENTS IN THE METROPOLITAN WATER SYSTEM.

*Be it enacted, etc., as follows:*

**Appropriations for construction for certain purposes in metropolitan water district.**

SECTION 1. The sum of nine hundred and thirty-nine thousand five hundred dollars is hereby appropriated, to be paid out of the treasury of the commonwealth from the Metropolitan Water Loan Fund for the following purposes: — For a sixty inch main from the terminus of the Weston aqueduct to connect with the present mains near Chestnut Hill reservoir; for additional pumping machinery for the high service at the Chestnut Hill pumping station; for the construction of sewers and cesspools and for other improvements necessary for the watershed of the Wachusett reservoir; for a new main for the water supply of the town of Winthrop; and for small extensions of the distribution system.

Issue of bonds authorized.

SECTION 2. For the purposes aforesaid the metropolitan water and sewerage board may, in addition to providing for the improvements for which expenditures are authorized by chapter five hundred and fifty-eight of the acts of the year nineteen hundred and eight, expend any sum heretofore appropriated for the construction of the metropolitan water works. To meet the further expenditures incurred under the provisions of this act, and not so provided for, the treasurer and receiver general shall, from time to time, issue upon the request of said board, bonds in the name and behalf of the commonwealth, to be designated on the face thereof, Metropolitan Water Loan, Act of 1909, to an amount not exceeding nine hundred thousand dollars, in addition to the sum of forty million eight hundred and ninety-eight thousand dollars authorized to be issued under the provisions of chapter four hundred and eighty-eight of the acts of the year eighteen hundred and ninety-five, chapter four hundred and fifty-three of the acts of the year nineteen hundred and one, chapter three hundred and sixty-seven of the acts of the year nineteen hundred and six and chapter five hundred and fifty-eight of the acts of the year nineteen hundred and eight, and the provisions of said chapter four hundred and eighty-eight of the acts of the year eighteen hundred and ninety-five and of acts in amendment thereof and in addition thereto shall apply to this additional loan.

Application of funds received from town of Swampscott for admission.

SECTION 3. All sums which shall be received from the town of Swampscott for the admission of said town into the metropolitan water district shall be paid into the Metropolitan Water Loan Fund, and may be applied by the metropolitan water and sewerage board to the construction of works made necessary by the admission of said town into the metropolitan water district.

SECTION 4. This act shall take effect upon its passage. [*Approved April 26, 1909.*

[CHAPTER 433.]

### AN ACT TO PROVIDE FOR THE PROPER MAINTENANCE AND ENLARGEMENT OF WORKS FOR THE TREATMENT OR PURIFICATION OF SEWAGE.

*Be it enacted, etc., as follows:*

**Adequate works to be provided by cities and towns, etc., for the treatment of sewage.**

SECTION 1. Cities, towns, persons, firms or corporations, owning or operating filter beds or other works for the treatment or purification of sewage shall provide and maintain works adequate for the treatment of the sewage at all times, and shall operate such works in such manner as will prevent a nuisance therefrom or the discharge or escape of unpurified or imperfectly purified sewage or effluent into any stream, pond or other water, or other objectionable result.

**Regulations, etc.**

SECTION 2. The board of sewer commissioners or other board or officer having charge of the sewers in cities and towns shall have authority to make such regulations regarding the use of the sewers as are necessary to prevent the entrance or discharge therein of any substance which may tend to interfere with the flow of sewage or the proper operation of the sewerage system or disposal works.

**Board of health may prohibit the entrance of waste, etc., into a sewer system.**

SECTION 3. The state board of health, if convinced, upon examination, that a filter bed or other works for the treatment or purification of sewage causes the pollution of a stream, pond or other water, or is likely to become a source of nuisance or create objectionable results in its neighborhood by reason of defective construction, inadequate capacity or negligence or inefficiency in maintenance or operation or from other cause, may issue notice in writing to the city, town or person owning or operating such works requiring such enlargement or improvement in the works or change in the method of operation thereof as may be necessary for the proper maintenance and operation of the works and the efficient purification and disposal of the sewage. In case the state board of health is satisfied after investigation that the unsatisfactory operation of a sewage disposal system is due wholly or partly to the discharge into the system of manufacturing waste or other substance of such character as to interfere with the efficient operation of said works, said board may if necessary prohibit the entrance of such waste or other material or may regulate the entrance thereof into the system, or may require the treatment of such waste or other material in such manner as may be necessary to prevent its interference with the operation of the works.

**Enforcement of provisions.**

SECTION 4. The supreme judicial court, or the superior court, shall have jurisdiction in equity to enforce the provisions of this act upon petition of the state board of health or of any party interested.

SECTION 5. This act shall take effect upon its passage. [*Approved May 21, 1909.*

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[CHAPTER 473.]

### AN ACT TO AUTHORIZE THE METROPOLITAN WATER AND SEWERAGE BOARD TO SELL OR LEASE CERTAIN LAND FOR THE TRANSMISSION OF ELECTRIC POWER.

*Be it enacted, etc., as follows:*

**1895, 488, § 11, amended.**

SECTION 1. Section eleven of chapter four hundred and eighty-eight of the acts of the year eighteen hundred and ninety-five is hereby amended by inserting after the word "needed", in the fourteenth line, the words: — and may, in their discretion, by lease, license or other agreement, permit the construction and maintenance on any land under their control of towers, poles, wires and other structures for the purpose of transmitting electric power over lands and waters of the commonwealth held for water supply purposes: *provided,* that, in the opinion of the board, such lease, license or agreement will not affect or interfere with the metropolitan water supply; and *provided, further,* that no lease, license or agreement shall be given or made for a period of more than fifteen years, — so as to read as follows: — *Section 11.* Said board and any city, town or water company aforesaid, may agree with each other for the storing or pumping of water, or the furnishing of the same as aforesaid by either party to any city, town or company; and any such city, town or company may sell to said board, and said board may purchase any property of such city, town or company, whether taken by eminent domain or otherwise, that said board may deem desirable for use in furnishing, as aforesaid, water to any city, town or water company; and said board may sell at public or private sale any property, real or personal, whether taken by eminent domain or otherwise, no longer needed for the water works under their charge, or may from time to time lease any property not then so needed; and may, in their discretion, by lease, license or

**(Storing or pumping of water, purchase of property, etc.)**

other agreement, permit the construction and maintenance on any land under their control of towers, poles, wires and other structures for the purpose of transmitting electric power over lands and waters of the commonwealth held for water supply purposes: *provided,* that, in the opinion of the board, such lease, license or agreement will not affect or interfere with the metropolitan water supply; and *provided, further,* that no lease, license or agreement shall be given or made for a period of more than fifteen years. The proceeds from the operations of said board shall be paid into the treasury of the commonwealth.

**Provisos.**

SECTION 2. This act shall take effect upon its passage. [*Approved June 4, 1909.*

[CHAPTER 479.]

### AN ACT TO AUTHORIZE THE TOWN OF FRAMINGHAM TO PROCURE AND USE ELECTRICITY FOR CERTAIN MUNICIPAL PURPOSES.

*Be it enacted, etc., as follows:*

**Town of Framingham may erect structures for transmission of electricity.**

SECTION 1. The town of Framingham is hereby authorized to erect, maintain and use poles, wires and other fixtures, appliances and apparatus in, under, over and upon any lands, public ways or lanes therein for the transmission of electricity generated by it or purchased from any person, firm or corporation now or hereafter authorized by law to distribute and sell electricity in said town, the same to be used in its water works and sewage disposal pumping stations, and for the purification of its sewage and water supply, but for no other purpose: *provided, however,* that no such poles, wires, fixtures, appliances or apparatus shall be erected or maintained in, under, over or upon any lands belonging to the commonwealth or subject to the jurisdiction of the metropolitan water and sewerage board. The authority to generate electricity for the purposes of this act shall only be exercised after the affirmative vote of two thirds of the voters present and voting thereon at each of two town meetings called for the purpose and held at intervals of not less than two nor more than four months. Nothing herein contained shall authorize said town to acquire a plant for the manufacture or distribution of electricity for other municipal uses or for the use of its inhabitants, save upon the proceeding required by and subject to the provisions

**Lands of commonwealth excepted.**

of chapter thirty-four of the Revised Laws and all amendments thereof now or hereafter enacted. The said town, for the purpose aforesaid, may take, or acquire by purchase or otherwise, and hold such lands, easements and rights of way as may be needed therefor. Such taking shall be in the manner provided by chapter two hundred and six of the acts of the year eighteen hundred and ninety-three, and the town shall be liable for all damages to property sustained by any person or corporation by reason of any taking or other act made or done under authority hereof.

SECTION 2. This act shall take effect upon its passage. [*Approved June 9, 1909.*

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## RESOLVES.

[CHAPTER 56.]

### RESOLVE IN FAVOR OF MICHAEL NAGLE.

**Michael Nagle.**

*Resolved,* That there be allowed and paid out of the North Metropolitan System Maintenance Fund, to Michael Nagle of Boston, the sum of forty-five dollars, in full compensation for loss of clothing, money and personal effects, sustained by him while endeavoring to protect the property of the commonwealth at the time of the Chelsea fire, April twelfth, nineteen hundred and eight. [*Approved April 26, 1909.*

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[CHAPTER 57.]

### RESOLVE IN FAVOR OF PATRICK CROWLEY.

**Patrick Crowley.**

*Resolved,* That there be allowed and paid out of the North Metropolitan System Maintenance Fund, to Patrick Crowley of Boston, the sum of one hundred three dollars and fifty cents, in full compensation for loss of clothing, money and articles of personal adornment, sustained by him while endeavoring to protect the property of the commonwealth at the time of the Chelsea fire, April twelfth, nineteen hundred and eight. [*Approved April 26, 1909.*

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AFFECTING THE

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